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AS PER LATEST CBSE CURRICULUM 2024-25

Chapter 1: Number System

Concepts Covered:

1.	**Introduction to Number Systems** ➢ Definition ➢ Natural numbers ➢ Whole numbers ➢ Integer ➢ Rational number ➢ Irrational number
2.	**Irrational Numbers** ➢ Definition ➢ Irrational Number Symbol ➢ Properties of Irrational Numbers
3.	**Real Numbers and Their Decimal Expansions** ➢ Decimal Expansion of Rational Numbers • Decimal Expansion ➢ Terminating and Non-Terminating Decimals • Terminating • Non-terminating or recuring • Non-terminating non recuring • Terminating and Non-Terminating Decimals Representation
4.	**Representing Real Numbers on the Number Line**
5.	**Operations on Real Numbers**
6.	**Laws of Exponents for Real Numbers** ➢ Exponent Definition ➢ Laws of Exponents ➢ Product With the Same Bases • Quotient with Same Bases • Power of a Power • Product to a Power • Quotient to a Power • Zero Power Rule • Negative Exponent Rule • Fractional Exponent Rule
7.	**Mind Map** **(Colourful & Interactive/ Complete All Concept Covered)**
	Practice Questions (All Topics Available)

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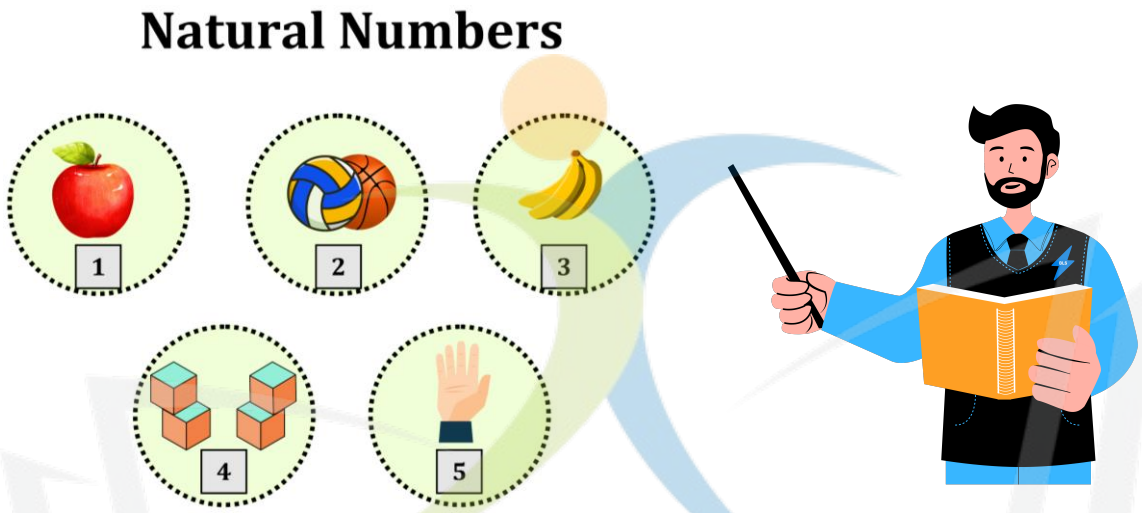
INTRODUCTION TO NUMBER SYSTEMS

The collection of numbers is called the number system. These numbers are of different types such as natural numbers, whole numbers, integers, rational numbers, and irrational numbers.

Natural Numbers



Natural numbers are the numbers that are used for counting and are a part of real numbers. The set of natural numbers includes only the positive integers, i.e., 1, 2, 3, 4, 5, 6, …….∞.

Examples: A few examples of natural numbers are 23, 56, 78, 999, 100202, and so on.

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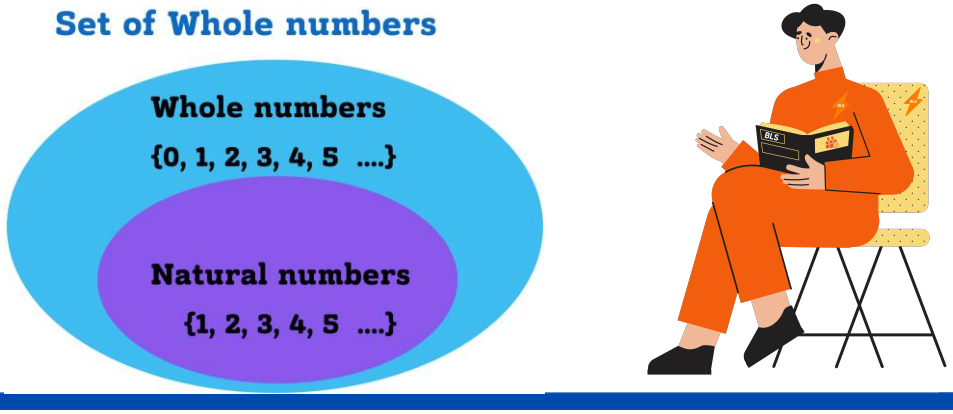
Whole numbers:



Whole numbers (W) are 0, 1, 2 and so on. Whole numbers are all natural numbers, including '0'. Whole numbers do not include any fractions, negative numbers or decimals.

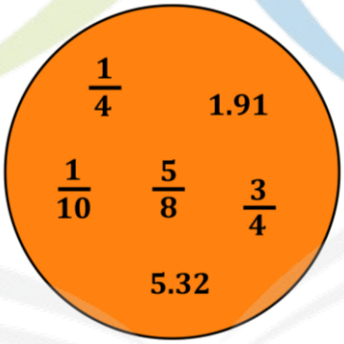
Integers:

Integers are numbers that include whole numbers along with negative numbers. An integer is a number from a set of negative and positive numbers, including zero, which has no decimal or fractional value. -3, 2, 0, 15, 900, etc., are examples of integers. Z is the symbol for a set of integers.

Example:

- **Negative:** -1, -2, -3, -4, -5
- **Non-negative:** 0, 6, 7, 8, 9
- **Positive:** 1, 2, 3, 4, 5
- **Zero:** 0 all by itself

Rational Numbers:



A number 'r' is called a rational number if it can be written in the form $\frac{p}{q}$, where p and q are integers and q ≠ 0.

Some examples of rational numbers include $\frac{3}{5}, \frac{7}{2}, \frac{11}{13}$, and so on.

Examples: $0\left(\text{which can be written as } \frac{0}{1}\right)$

- $19\left(\text{which can be written as } \frac{19}{1}\right)$
- $\frac{2}{9}$
- $\sqrt{64}$ which gives 4 or $\frac{4}{1}$
- $-\frac{6}{7}$
- $0.333333 = \frac{1}{3}$
- $-0.9 = -\frac{9}{10}$

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Irrational number:

Any number that cannot be expressed in the form of $\frac{p}{q}$, where p and q are integers and q ≠ 0, is an irrational number.

Example: $\sqrt{2}, 1.010024563 \ldots, e, \pi$

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IRRATIONAL NUMBERS

Definition

Irrational Numbers are numbers that cannot be expressed in the form of $\frac{p}{q}$ where p and q are integers and q does not equal zero. Irrational numbers cannot be represented via fractions or normal decimal values. They are non-recurring, non-terminating, and non-repeating decimals. They are part of real numbers but are different from rational numbers. We represent the Irrational number by the symbol Q'.

Irrational Number

$\sqrt{2} = 1.4142135 \ldots$

$\sqrt[3]{5} = 1.7099759 \ldots$

$\pi = 3.14159265 \ldots$

Irrational Number Symbol

We represent the Irrational number with the symbol Q' as Q represents the group of rational numbers so Q complement (Q') is used to represent irrational numbers. Also,

Q U Q' = R

where R is the set of real numbers.

Properties of Irrational Numbers

Various properties of irrational numbers are discussed below:

- Sum of two rational numbers may be rational or may be irrational.
- Sum of a rational number and an irrational number is an irrational number.
- Product of an irrational number with a non-zero rational number is an irrational number.
- Product of two irrational numbers may be rational or may be irrational.
- LCM of two irrational numbers may or may not exist.
- Set of irrational numbers is not closed under the multiplication process, but a set of rational numbers is closed.

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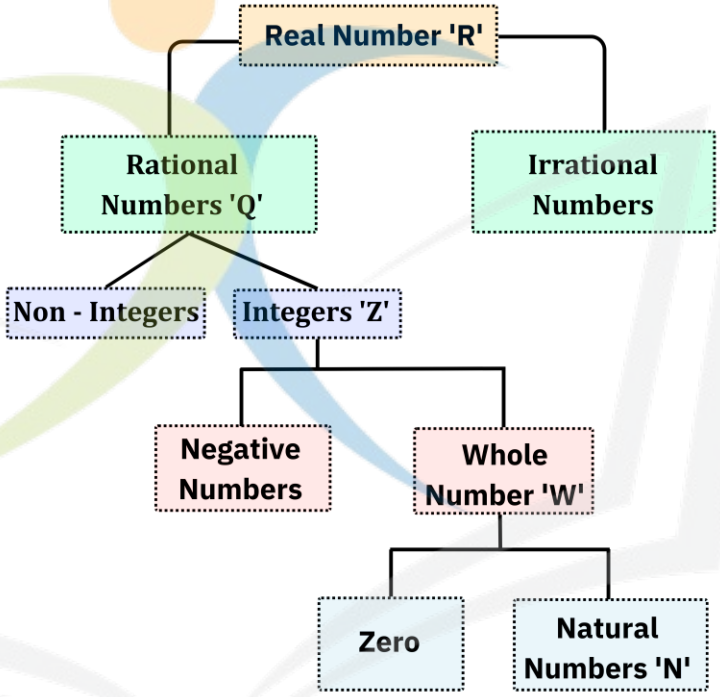
REAL NUMBERS AND THEIR DECIMAL EXPANSIONS

Decimal Expansion of Rational Numbers

The Combination of a set of rational and irrational numbers is called real numbers. All the real numbers can be expressed on the number line. The numbers other than real numbers that cannot be represented on the number line are called imaginary numbers (unreal numbers). They are used to represent complex numbers. Below is a classification diagram of real numbers.



Decimal Expansion:

Before going into a representation of the decimal expansion of rational numbers, let us understand what rational numbers are. A Rational Number is a number that can be written in form of $\frac{p}{q}$ where p, q are Integers and q! = 0.

Example: $\frac{2}{3}, \frac{1}{4}, \frac{4}{5}$, etc. Rational numbers are denoted by Q. As every Integer can be represented in $\frac{p}{q}$ form so all Integers are rational numbers.

Example: -1, -2, -6, 4, 5 can be represented as $-\frac{1}{1}, -\frac{2}{1}, \frac{4}{1}, \frac{5}{1}$

There are generally 3 types of decimal expansion:

- Terminating
- Non-terminating Repeating
- Non-terminating non-Repeating

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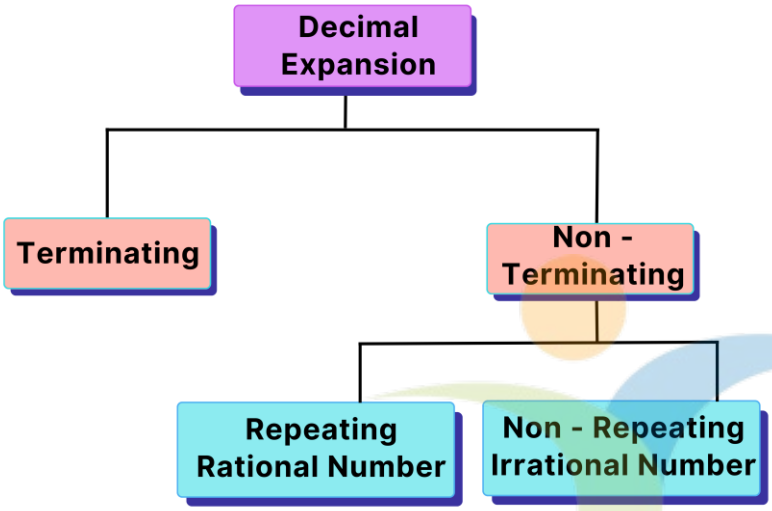
Decimal expansion of Rational Numbers



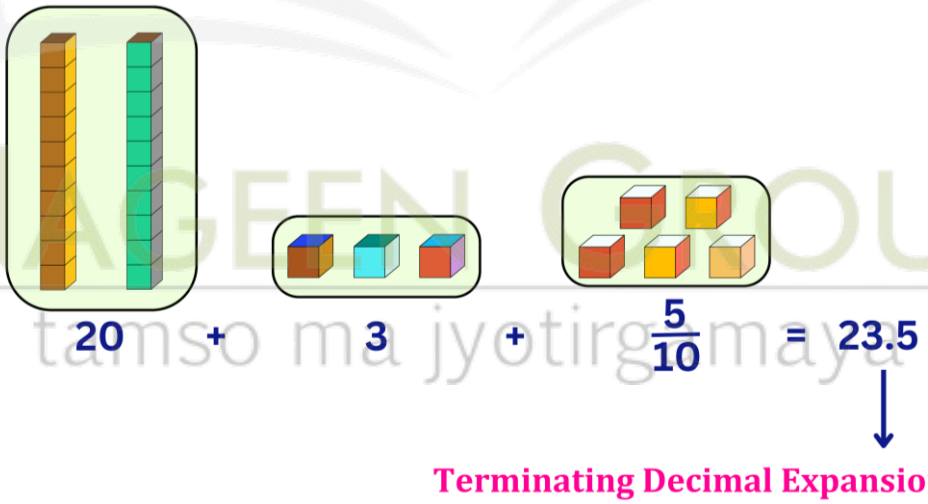
Terminating and Non-Terminating Decimals

A terminating decimal:

A terminating decimal is a decimal number with a finite number of digits after the decimal point.

Example: Express 0.2 in the form of $\frac{p}{q}$.

Solution: $0.2 = \frac{0.2 \times 10}{10} = \frac{2}{10} = \frac{1}{5}$



Non-terminating Decimal Definition: A non-terminating decimal has an infinite number of decimal places, and it is named as non-terminating because the decimal will never terminate. For example, 1.333333..., 4.65675747775..., etc.

Example: 0.2857142857 and $0.3333 \ldots . = \overline{0.3}$

There are two forms of non-terminating decimal expansions, they are:

1. Non-terminating recurring decimal expansion
2. Non-terminating non-recurring decimal expansion

Non-Terminating Decimal Expansion

Non-Terminating Non-Recurring Decimal Expansion:

A non-terminating, non-recurring decimal in which the digits after the decimal point do not repeat and do not terminate.

Example: 1.4142135623…,1.7320508075… and 2.2360679774…

```
      0.142857
   ____________
7 ) 10
    -7
    ---
     30
    -28
    ---
      20
     -14
     ---
      60
     -56
     ---
      40
     -35
     ---
      50
     -49
     ---
       1
```

Terminating and Non-Terminating Decimals Representation:

Non-terminating non-recurring decimal is also known by the name non-terminating non-repeating decimal as the values after decimal do not repeat or terminate. For example, 1.4142135..., 2.35638745... Unlike non-terminating recurring decimal, the decimal places do not form any pattern.

Steps to Convert Non-Terminating Recurring Decimal to Rational Number.

Step 1: Assume the repeating decimal to be equal to some variable x.

Step 2: Write the number without using a bar and equal to x. (Bar is for digits that repeat in the same pattern)

Step 3: Determine the number of digits having a bar on their heads or the number of digits before the bar for mixed recurring decimal.

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Step 4: If the repeating number is the same digit after decimal such as 0.2222... then multiply by 10, if repetition of the digits is in pairs of two numbers such as 0.7878... then multiply by 100 and so on.

Step 5: Subtract the equation formed by step 2 and step 4.

Step 6: Then find the value of x in the simplest form.

Example: Convert 0.7777… into rational fraction.

Solution: Step 1: x = 0.7777

Step 2: After examining we find that repeating digit is 7.

Step 3: Place the repeating digit (7) to the left of decimal point. To do so, we need to move the decimal point 1 place to the right. This can also be done by multiplying the given no. by 10.

So, 10x = 7.777

Step 4: After step 3 place the repeating digits to the right of decimal point. In this case if we place the repeating digits to the right of decimal point it becomes the original number.

x = 0.7777

Step 5: The two equations are-

x = 0.7777,

$\Longrightarrow$ 10x = 7.777

Now we have to subtract the right- and left-hand sides-

10x - x = 7.777 - 0.7777

$\Longrightarrow$ 9x = 7.0

$\Longrightarrow$ x = 7979

Hence, x = 7979 is the required rational number.

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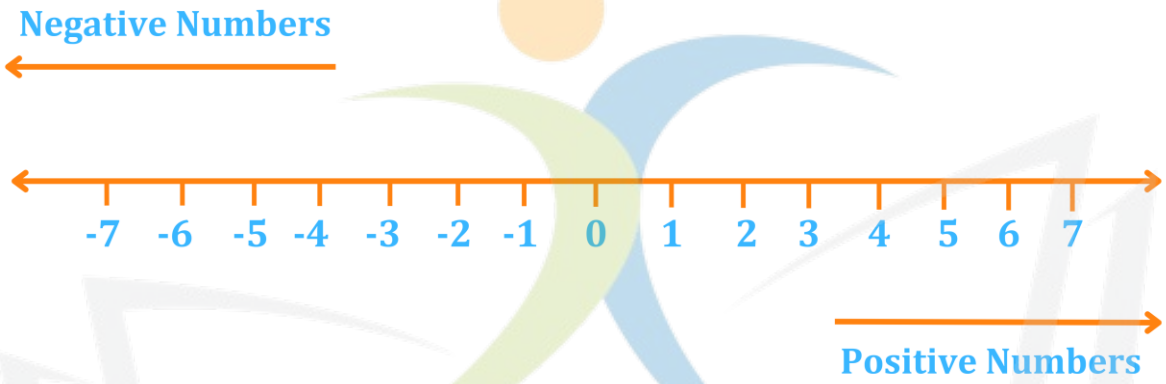
REPRESENTING REAL NUMBERS ON THE NUMBER LINE

A real number line simply called a number line, represents real numbers with unique points associated with each number on the line.

In the number line, the number 0 is called the origin. All the positive numbers or integers are represented on the right side of the origin, and the negative numbers or integers are represented on the left side of the origin.



Steps to Represent Real Numbers on a Number Line

Step 1: Draw a horizontal line with arrows on both ends and mark off the number 0 anywhere. The number 0 is called the origin.

Step 2: Mark real numbers in equal length on both sides of the origin and label them with a definite scale.

Step 3: Positive numbers lie on the right side of the origin and the negative numbers lie on the left side of the origin.

Step-4: Natural numbers, whole numbers, and integers can be marked easily by locating that particular point on the number line. If the given point is a large number let's say 100, we can change the number line scale accordingly. In this case, we can choose 1 unit as 20, so to mark 100, we just have to take 5 steps towards the right side of the origin.

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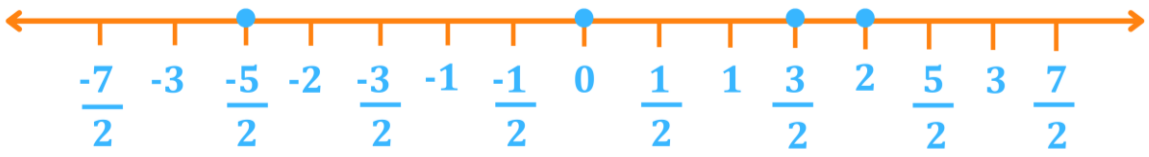
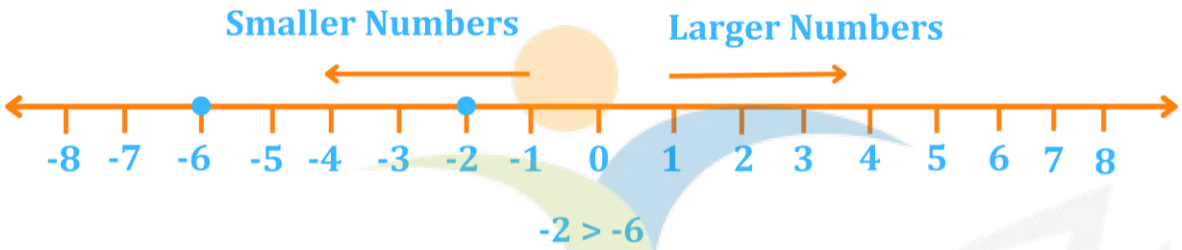
Step-5: Rational numbers and irrational numbers can be first converted to their decimal equivalents, and then we can mark them on the number line. Sometimes, it is not possible to mark a number on the exact point, so we have to consider the approximate decimal values of the numbers.

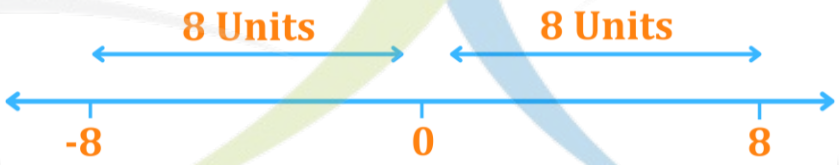
Example: Mark the real numbers $-\frac{5}{2}, 0, \frac{3}{2}$ and 2 on a number line.



Ordering of Real Numbers on a Number Line



Opposite Real Numbers on a Number Line



Absolute Value of a Real Numbers on a Number Line

Representing Real Numbers on the Number Line

To represent the real numbers on the number line we use the process of successive magnification in which we visualize the numbers through a magnifying glass on the number line.

Example: Mark $4.\overline{26}$ on the number line up to 4 decimal places.

Step 1: The number lies between 4 and 5, so we divide it into 10 equal parts. Now for the first decimal place, we will mark the number between 4.2 and 4.3.

Step 2: Now we will divide it into 10 equal parts again. The second decimal place will be between 4.26 and 4.27.

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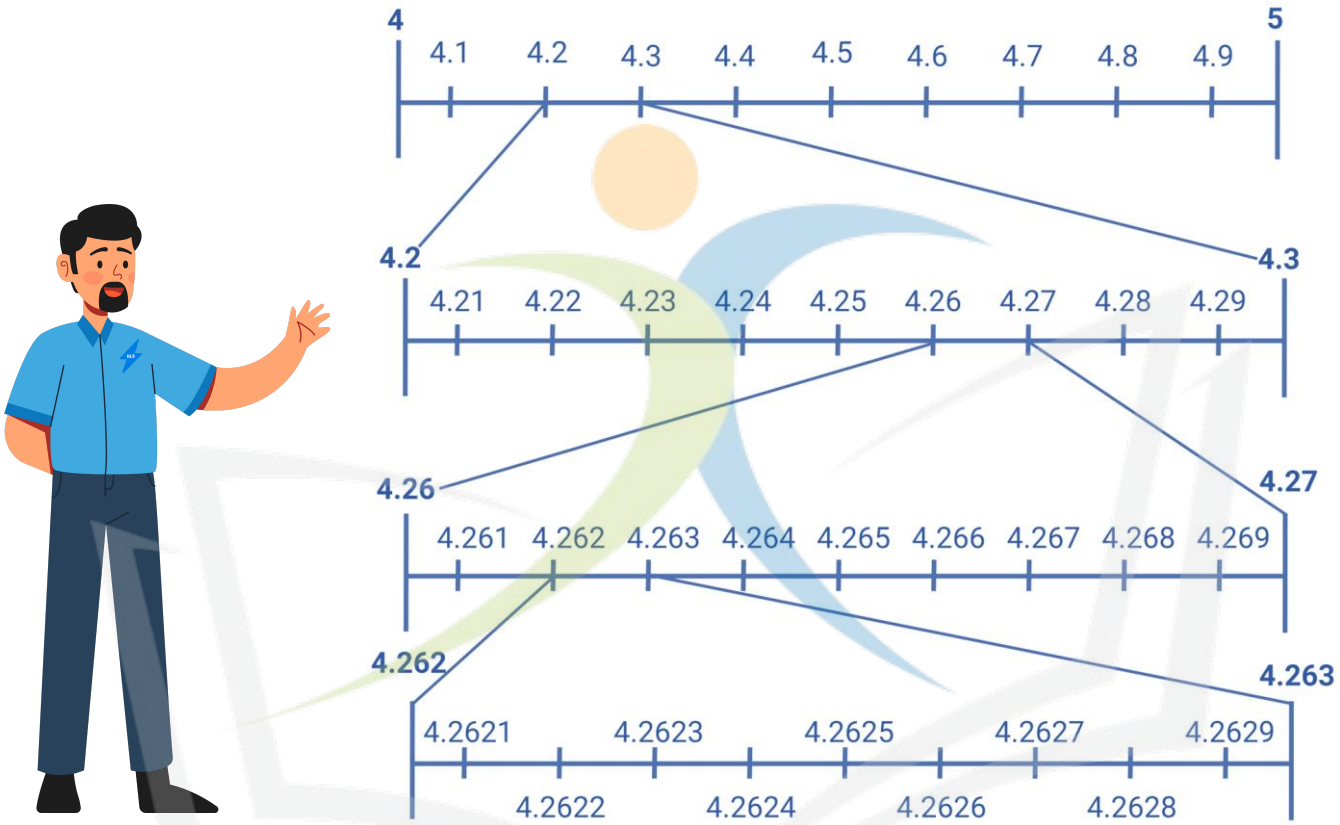
Step 3: Now we will again divide it into 10 equal parts. The third decimal place will be between 4.262 and 4.263.

Step 4: By doing the same process again we will mark the point at 4.2626.



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OPERATIONS ON REAL NUMBERS

The following pointers are to be kept in mind when you deal with real numbers and mathematical operations on them:

- When the addition or subtraction operation is done on a rational and irrational number, the result is an irrational number.
- When the multiplication or division operation is done on a rational number with an irrational number, the result is an irrational number.
- When two irrational numbers are added, subtracted, multiplied, or divided, the result may be a rational or an irrational number.

If a and b are positive real numbers, then we have:

$\sqrt{ab} = \sqrt{a}\sqrt{b}$

$\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$

$(\sqrt{a} + \sqrt{b})(\sqrt{a} - \sqrt{b}) = a - b$

$(a + \sqrt{b})(a - \sqrt{b}) = a^2 - b$

$(\sqrt{a} + \sqrt{b})(\sqrt{c} + \sqrt{d}) = \sqrt{ac} + \sqrt{ad} + \sqrt{bc} + \sqrt{bd}$

$(\sqrt{a} + \sqrt{b})2 = a + 2\sqrt{ab} + b$

Example: Solve $(2\sqrt{2} + 7\sqrt{7}) + (13\sqrt{2} - 4\sqrt{7})$.

Solution: $(2\sqrt{2} + 7\sqrt{7}) + (13\sqrt{2} - 4\sqrt{7})$

$= (2\sqrt{2} + 13\sqrt{2}) + (7\sqrt{7} - 4\sqrt{7})$

$= (2 + 13)\sqrt{2} + (7 - 4)\sqrt{7}$

$= 15\sqrt{2} + 3\sqrt{7}$

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Operations on Real Numbers

Example: The sum, difference, product and quotient of two rational numbers will be rational.

Solution: $\Rightarrow \frac{3}{4} + \frac{7}{4} = \frac{10}{4} = \frac{5}{2}$

$\Rightarrow \frac{7}{4} - \frac{3}{4} = \frac{4}{4} = 1$

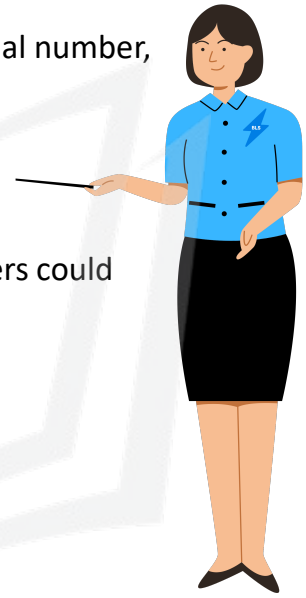
$$\Rightarrow \frac{7}{4} \times \frac{3}{4} = \frac{21}{16}$$

$$\Rightarrow \frac{7}{4} \div \frac{3}{4} = \frac{7}{3}$$

Example: If we add or subtract a rational number with an irrational number then the outcome will be irrational.

Solution: If 5 is a rational number and $\sqrt{7}$ is an irrational number then $5 + \sqrt{7}$ and $5 - \sqrt{7}$ are irrational numbers.

Example: If we multiply or divide a non-zero rational number with an irrational number, then also the outcome will be irrational.



Solution: If 7 is a rational number and $\sqrt{5}$ is an irrational number then $7\sqrt{7}$ and $\frac{7}{\sqrt{5}}$ are irrational numbers.

Example: The sum, difference, product and quotient of two irrational numbers could be rational or irrational.

Solution: $\sqrt{3} + \sqrt{3} = 2\sqrt{3}$ (irrational + irrational = irrational)

$\sqrt{2} - \sqrt{2} = 0$ (irrational − irrational = rational)

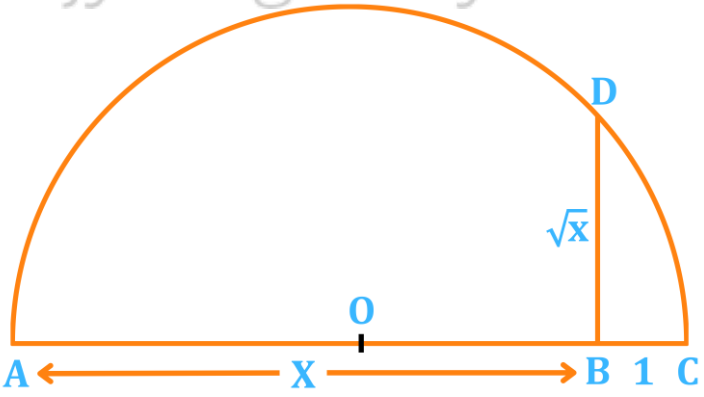
$(\sqrt{6}) \times (\sqrt{6}) = 6$ (irrational × irrational = rational)

$\frac{\sqrt{13}}{\sqrt{13}} = 1 \times$ (irrational ÷ irrational = rational)

Finding Roots of a Positive Real Number 'x' geometrically and mark it on the Number Line

To find $\sqrt{x}$ geometrically:

- First of all, mark the distance x unit from point A on the line so that AB = x unit.
- From B mark a point C with the distance of 1 unit, so that BC = 1 unit.
- Take the midpoint of AC and mark it as O. Then take OC as the radius and draw a semicircle.
- From the point B draw a perpendicular BD which intersects the semicircle at point D.



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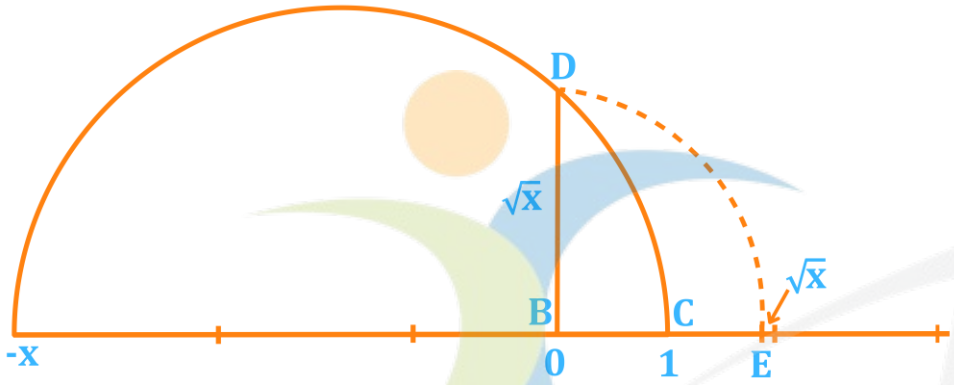
The length of BD $= \sqrt{x}$.

To mark the position of $\sqrt{x}$ on the number line, we will take AC as the number line, with B as zero. So, C is point 1 on the number line.

Now we will take B as the centre and BD as the radius, and draw the arc on the number line at point E.



Now E is $\sqrt{x}$ on the number line.

Rationalizing the Denominator

Rationalize the denominator means to convert the denominator containing square root term into a rational number by finding the equivalent fraction of the given fraction.

For which we can use the identities of the real numbers.

Example: Rationalize the denominator of $\frac{7}{7-\sqrt{3}}$.

Solution: We will use the identity $(p+\sqrt{q})(p-\sqrt{q}) = p^2 - q$ here.

$$\frac{7}{7-\sqrt{3}} \times \frac{7+\sqrt{3}}{7+\sqrt{3}} = \frac{7(7+\sqrt{3})}{49-3} = \frac{49+7+\sqrt{3}}{46}$$

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LAWS OF EXPONENTS FOR REAL NUMBERS

Exponent Definition

Exponents are used to show repeated multiplication of a number by itself. For example, 7 × 7 × 7 can be represented as 7^3. Here, the exponent is '3' which stands for the number of times. The number 7 is the base here which is the actual number that is getting multiplied. So basically, exponents or powers denotes the number of times a number can be multiplied. If the power is 2, that means the base number is multiplied two times with itself.

Examples:

$3^4 = 3 \times 3 \times 3 \times 3$

$10^5 = 10 \times 10 \times 10 \times 10 \times 10$

$16^3 = 16 \times 16 \times 16$

Suppose a number 'a' is multiplied by itself n-times, then it is represented as an where a is the base and n is the exponent.

$$a^n = \underbrace{a \times a \times a \times \ldots\ldots\ldots\ldots \times a}_{n-\text{times}}$$

Laws of Exponents

The important laws of exponents are given below:

$a^m \times a^n = a^{m+n}$

$\frac{a^m}{a^n} = a^{m-n}$, m > 0

$(a^m)^n = a^{mn}$

$(a.b)^m = a^m b^m$

$\frac{a^n}{b^n} = \left(\frac{a}{b}\right)^n$

$a^0 = 1$

$a^{-m} = \frac{1}{a^m}$

$a^{\frac{1}{n}} = \sqrt[n]{a}$

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Product With the Same Bases

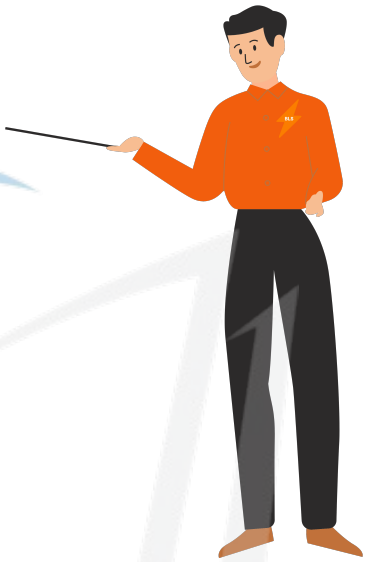
As per this law, for any non-zero term a,

$a^m \times a^n = a^{m+n}$

where m and n are real numbers.

Example: What is the simplification of $5^5 \times 5^1$?

Solution: $5^5 \times 5^1 = 5^{5+1} = 5^6$



Quotient with Same Bases

As per this rule,

$$\frac{a^m}{a^n} = a^{m-n}$$

where a is a non-zero term and m and n are integers.

Example: $\frac{x^4}{x^2} = \frac{xxxx}{xx}$

$= x^{4-2} = x^2$

Power of a Power

According to this law, if 'a' is the base, then the power raised to the power of base 'a' gives the product of the powers raised to the base 'a', such as.

$(a^m)^n = a^{mn}$

where a is a non-zero term and m and n are integers.

Example: $(x^3)^2 = (xxx)^2 = (xxx)(xxx) = x^6 = x^{(3 \times 2)}$

Product to a Power

As per this rule, for two or more different bases, if the power is same, then.

$a^n\, b^n = (ab)^n$

where a is a non-zero term and n is the integer.

Example: Simplify and write the exponential form of: $\frac{1}{8} \times 5 - 3$

Solution: We can write, $\frac{1}{8} = 2 - 3$

Therefore, 2 - 3 × 5 - 3 = (2 × 5) - 3 = 10 - 3

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Quotient to a Power

As per this law, the fraction of two different bases with the same power is represented as.

$$\frac{a^n}{b^n} = \left(\frac{a}{b}\right)^n$$

where a and b are non-zero terms and n is an integer.

Example: Simplify the expression and find the value: $\frac{15^3}{5^3}$

Solution: We can write the given expression as.

$$\left(\frac{15}{5}\right)^3 = 3^3 = 27$$

Zero Power Rule

As long as x is not equal to zero, raising it to the power of zero should give us 1 as result.

$a^0 = 1, a \neq 1.$

Example: $1 = 1 = \frac{x^a}{x^a} = x^{a-a} = x^0$

Negative Exponent Rule

According to this rule, if the exponent is negative, we can change the exponent into positive by writing the same value in the denominator and the numerator holds the value 1.

The negative exponent rule is given as:

$$a - m = \frac{1}{am}$$

Example: Find the value of 2 - 2

Solution: Here, the exponent is a negative value (i.e., -2)

Thus, 2 - 2 can be written as $\frac{1}{2^2}$

$$2 - 2 = \frac{1}{2^2}$$

$$2 - 2 = \frac{1}{4}$$

In other words, we can say that, if “a” is a non-zero number or non-zero rational number, we can say that a-m is the reciprocal of am.

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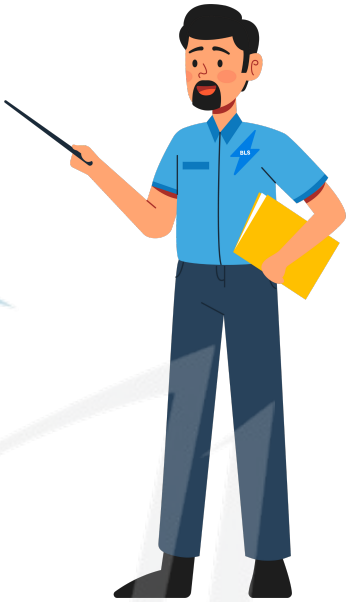
Fractional Exponent Rule

The fractional exponent rule is used, if the exponent is in the fractional form. The fractional exponent rule is given by:

$a^{\frac{1}{n}} = \sqrt[n]{a}$



Here, a is called the base, and $\frac{1}{n}$ is the exponent, which is in the fractional form. Thus, $a^{\frac{1}{n}}$ is said to be the nth root of a.

Example: Simplify: $\frac{41}{2}$

Solution: Here, the exponent is in fractional form. $(\text{i.e.}, \frac{1}{2})$

According to the fractional exponent rule, $\frac{41}{2}$ can be written as $\sqrt{4}$

$(\text{i.e.},) \frac{41}{2} = \sqrt{4}$

$\frac{41}{2} = 2$ (As, the square root of 4 is 2)

Hence, the simplified form of $\frac{41}{2}$ is 2.

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(Practice Sheet)

1 **Which set of numbers includes only positive integers used for counting?**

A. Whole Numbers **B.** Integers

C. Rational Numbers **D.** Irrational Numbers

2 **What is the defining characteristic of irrational numbers?**

A. They can be expressed as $\frac{p}{q}$ **B.** They are all positive integers

C. They have decimal or fractional values **D.** They are part of the set of integers

3 **Which symbol represents the set of integers?**

A. N **B.** W

C. Z **D.** Q

4 **Which of the following is not a natural number?**

A. 0 **B.** 1

C. 2 **D.** -1

5 **What type of number is 0.333333, expressed as $\frac{1}{3}$?**

A. Natural Number **B.** Rational Number

C. Whole Number **D.** Irrational Number

6 What is the set of natural numbers, and can you provide three examples of natural numbers?

7 Define integers and provide examples, including both positive and negative integers.

8 Explain what makes a number rational and give three examples of rational numbers.

9 Differentiate between natural numbers, whole numbers, and integers. Provide one example for each category.

10 What distinguishes an irrational number, and can you give two examples of irrational numbers?

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(Practice Sheet)

1 **What defines an irrational number?**

A. Can be expressed as $\frac{p}{q}$
B. Is a non-recurring decimal
C. Is a whole number
D. Has a terminating decimal

2 **Which symbol is used to represent irrational numbers?**

A. Q
B. R
C. Q'
D. I

3 **Which of the following is an example of an irrational number?**

A. $\frac{3}{4}$
B. $\sqrt{2}$
C. 0.25
D. 5

4 **What is the sum of a rational number and an irrational number?**

A. Always rational
B. Always irrational
C. May be rational or irrational
D. Undefined

5 **What property does the set of irrational numbers not possess?**

A. Closed under multiplication
B. Closed under addition
C. Closed under subtraction
D. Closed under division

6 Provide a definition of irrational numbers. Can irrational numbers be expressed in the form $\frac{p}{q}$? Explain.

7 Give three examples of irrational numbers and explain why each of them is considered irrational.

8 How are irrational numbers represented symbolically, and what does the symbol Q' signify?

9 Discuss two properties of irrational numbers related to their sums and products with rational numbers.

10 The sum of a rational and an irrational number is irrational, and the product of an irrational number with a non-zero rational number is irrational.

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(Practice Sheet)

1 **Which set of numbers includes both rational and irrational numbers?**

A. Imaginary Numbers
B. Complex Numbers
C. Real Numbers
D. Natural Numbers

2 **What is the defining characteristic of a terminating decimal?**

A. Infinite digits after the decimal point
B. Non-repeating digits
C. Finite digits after the decimal point
D. Non-terminating recurring digits

3 **Which type of decimal expansion has digits after the decimal point that do not repeat and do not terminate?**

A. Non-terminating recurring decimal
B. Non-terminating non-recurring decimal
C. Terminating decimal
D. Mixed recurring decimal

4 **What is the first step in converting a recurring decimal to a rational number?**

A. Multiply by 10
B. Assume the recurring decimal as a variable
C. Subtract the equations formed by step 2 and step 4
D. Determine the number of repeating digits

5 **Convert 0.7777... into a rational fraction.**

A. $\frac{7}{9}$
B. $\frac{7}{99}$
C. $\frac{77}{99}$
D. $\frac{79}{99}$

6 Define imaginary numbers and their relation to real numbers in the context of the number line.

7 Provide an example of a non-terminating recurring decimal and a non-terminating non-recurring decimal.

8 Explain the concept of a rational number and its representation in decimal form. Provide an example.

9 Outline the steps to convert a non-terminating recurring decimal into a rational number.

10 Discuss the properties of terminating and non-terminating decimal expansions, emphasizing their significance in the classification of real numbers.

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(Practice Sheet)

1 **On a number line, where are positive numbers or integers typically represented?**

A. To the right of the origin
B. To the left of the origin
C. At the origin
D. Above the origin

2 **What is the first step in representing real numbers on a number line?**

A. Mark the natural numbers
B. Draw a horizontal line with arrows
C. Identify the origin
D. Label positive numbers

3 **How are real numbers ordered on a number line?**

A. Increasing from left to right
B. Decreasing from left to right
C. Alternating between positive and negative
D. Randomly

4 **Where does the absolute value of a real number appear on a number line?**

A. To the left of the origin
B. To the right of the origin
C. At the origin
D. At both sides of the origin

5 **How are rational and irrational numbers marked on a number line?**

A. They cannot be represented on a number line
B. By converting them to decimal equivalents
C. By using imaginary coordinates
D. By skipping them on the number line

6 Explain the process of marking the real number 3.75 on a number line. Consider each decimal place separately.

7 How are opposite real numbers represented on a number line? Provide an example.

8 Explain the process of representing real numbers on the number line using the technique of successive magnification.

9 If three real numbers are marked on a number line, -2, 0, and 5, in which order are they positioned?

10 What does the absolute value of a real number signify on the number line, and how is it determined?

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(Practice Sheet)

1 **What is the result when an irrational number is added to a rational number?**

A. Always rational
B. Always irrational
C. May be rational or irrational
D. Neither rational nor irrational

2 **In the geometric representation of $\sqrt{x}$, which point on the number line is taken as the center for drawing the semicircle?**

A. A
B. B
C. C
D. O

3 **What does it mean to rationalize the denominator of a fraction?**

A. Convert the numerator to a rational number
B. Convert the denominator to a rational number
C. Simplify the fraction
D. Convert the numerator and denominator to irrational numbers

4 **If 5 is a rational number and $\sqrt{6}$ is an irrational number, what is the sum $5 + \sqrt{6}$?**

A. Rational
B. Irrational
C. May be rational or irrational
D. Neither rational nor irrational

5 **What can be the result when two irrational numbers are multiplied?**

A. An irrational number
B. Rational Number
C. May be rational or irrational
D. Neither rational nor irrational

6 Rationalize the denominator of $\frac{1}{2-\sqrt{3}}$

7 Rationalize the denominator of $\frac{1}{5+\sqrt{3}}$

8 In the following examples a and b are irrational numbers.
$a = (2+\sqrt{5}), b = (3-\sqrt{5})$

9 In the following examples a and b are irrational numbers.
$a = \pi, b = 6+\pi$

10 Solve $(2\sqrt{2}+7\sqrt{7})+(13\sqrt{2}-4\sqrt{7})$.

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(Practice Sheet)

1 **What does the exponent 'n' represent in the expression a^n?**

A. Base
B. Number of times the base is multiplied
C. Result of multiplication
D. Factor

2 **According to the law of exponents, what is the result of $a^m \times a^n$?**

A. a^{mn}
B. a^{m+n}
C. a^{m-n}
D. $a^{\frac{m}{n}}$

3 **What is the simplified form of $\frac{x^4}{x^2}$?**

A. $x^{(4-2)}$
B. x^6
C. x^2
D. x^8

4 **According to the power of a power law, what is $(a^m)^n$ equal to?**

A. a^{mn}
B. a^{m+n}
C. a^{m-n}
D. $a^{\frac{m}{n}}$

5 **What is the value of a^0, where 'a' is not equal to zero?**

A. 0
B. 1
C. a
D. Undefined

6 Simplify the expression: $3^{\frac{1}{2}}$.

7 Find the value of $5^{(-3)}$.

8 Evaluate $16^{\frac{3}{4}}$.

9 Express the result of $2^3 \times 2^5$ in exponential form.

10 Explain the significance of the zero-power rule and provide an example where it is applicable.

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EXEMPLAR SOLUTIONS

Chapter 1-
Number Systems

EXERCISE 1.1

Write the correct answer in each of the following:

1. Every rational number is

(A) a natural number
(B) an integer
(C) a real number
(D) a whole

number Solution:

(C) a real number

Explanation:

We know that rational and irrational numbers taken together are known as real numbers. Therefore, every real number is either a rational number or an irrational number. Hence, every rational number is a real number.

Hence, (C) is the correct option.

2. Between two rational numbers

(A) there is no rational number
(B) there is exactly one rational number
(C) there are infinitely many rational numbers
(D) there are only rational numbers and no irrational

numbers Solution:

(C) there are infinitely many rational numbers Explanation:

Between two rational numbers there are infinitely many rational number . Hence, (C) is the correct option.

3. Decimal representation of a rational number cannot be

(A) terminating
(B) non-terminating
(C) non-terminating repeating
(D) non-terminating non-repeating

Solution:

(D) non-terminating non-repeating Explanation:

The decimal representation of a rational number cannot be non-terminating and non- repeating . Hence, (D) is the correct option

4. The product of any two irrational numbers is

(A) always an irrational number
(B) always a rational number
(C) always an integer
(D) sometimes rational, sometimes irrational

Solution:

(D) sometimes rational, sometimes irrational

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Explanation:
The product of any two irrational numbers is sometimes rational and sometimes irrational.
Hence, (D) is the correct option

5. The decimal expansion of the number √2 is

(A) a finite decimal
(B) 1.41421
(C) non-terminating recurring
(D) non-terminating non-recurring

Solution:

(D) non-terminating non-recurring
Explanation:
The decimal expansion of the number √2 = 1.41421356237…
Hence, (D) is the correct option

6. Which of the following is irrational?

(A) √4/√9
(B) √12/√3
(C) √7
(D) √81

Solution:

(C) √7
Explanation:
(A) √4/√9 = 2/3
(B) √12/√3 = 2√3/√3 = 2
(C) √7 = 2.64575131106
(D) √81 = 9
Here, (C) √7 = 2.64575131106, is a non terminating decimal expansion.
Hence, (C) is the correct option

7. Which of the following is irrational?

(A) 0.14
(B) $0.14\overline{16}$
(C) $0.\overline{1416}$
(D) 0.4014001400014...

Solution:

(D) 0.4014001400014…
Explanation:
A number is irrational if and only of its decimal representation is non-terminating and non-recurring.
(A) is a terminating decimal and therefore cannot be an irrational number.
(B) is a non-terminating and recurring decimal and therefore cannot be irrational.
(C) is a non-terminating and recurring decimal and therefore cannot be irrational.
(D) is a non-terminating and non-recurring decimal and therefore is an irrational number.
Hence, (D) is the correct option.

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8. A rational number between √2 and √3 is

(A) (√2+√3)/2

(B) (√2. √3)/2

(C) 1.5

(D) 1.8

Solution:

(C) 1.5

Explanation:

√2 =1.4142135.... and √3 =1.732050807....

(A) (√2+√3)/2 = 1.57313218497… is a non-terminating and non-recurring decimal and therefore is an irrational number.

(B) (√2. √3)/2 = 1.22474487139… is a non-terminating and non-recurring decimal and therefore is an irrational number.

(C) 1.5 is a terminating decimal and therefore is a rational number.

(D) 1.8 is a terminating decimal and therefore is a rational number.

Here both 1.5 and 1.8 are rational numbers. But, 1.8 does not lie in between √2 =1.4142135.... and √3 =1.732050807.... Whereas 1.5 lies in between √2 =1.4142135.... and √3 =1.732050807....

Hence, (C) is the correct option.

9. The value of 1.999... in the form *p/q*, where *p* and *q* are integers and *q* ≠ 0 , is

(A) 19/10

(B) 1999/1000

(C) 2

(D) 1/9

Solution:

(C) 2

Explanation:

(A) 19/10 = 1.9

(B) 1999/1000= 1.999

(C) 2

(D) 1/9= 0.111….

Let x = 1.9999..... --- (1)

Multiply equation (1) with 10

10x = 19.9999..... --- (2)

Subtract equation (1) from equation(2) ,

We get,

9x = 18

x = 18 / 9

x = 2

Therefore,

x = 1.9999... = 2

Hence, (C) is the correct option.

10. 2√3 + √3 is equal to

(A) 2√6

(B) 6

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(C) $3\sqrt{3}$
(D) $4\sqrt{6}$

Solution:

(C) $3\sqrt{3}$

Explanation:

$2\sqrt{3} + \sqrt{3}$

Taking $\sqrt{3}$ common,

We get,

$\sqrt{3}(2+1) = \sqrt{3}(3) = 3\sqrt{3}$

Hence, (C) is the correct option.

EXERCISE 1.2

1. Let x and y be rational and irrational numbers, respectively. Is x + y necessarily an irrational number? Give an example in support of your answer.

Solution:

Yes, if x and y are rational and irrational numbers, respectively, then x+ y is an irrational number.

For example,

Let $x = 5$ and $y = \sqrt{2}$.

Then, $x+y = 5 + \sqrt{2} = 5 + 1.414\ldots = 6.414...$

Here, 6.414 is a non-terminating and non-recurring decimal and therefore is an irrational number.

Hence, x + y is an irrational number.

2. Let x be rational and y be irrational. Is xy necessarily irrational? Justify your answer by an example.

Solution:

No, if x is rational number and y is irrational number, then, xy is not necessarily an irrational number. It can be rational if $x = 0$, which is a rational number.

For Example:

Let $y = \sqrt{2}$, which is irrational.

Consider $x = 2$, which is rational.

Then, $x \times y = 2 \times \sqrt{2} = 2\sqrt{2}$, which is irrational.

Consider $x = 0$, which is rational.

Then $xy = 0 \times \sqrt{2} = 0$, which is rational.

$\therefore$, we can conclude that, the product of a rational and an irrational number is always irrational, only if the rational number is not zero.

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EXERCISE 1.3

1. Find which of the variables x, y, z and u represent rational numbers and which irrational numbers:

(i) $x^2 = 5$
(ii) $y^2 = 9$
(iii) $z^2 = .04$
(iv) $u^2 = 17/4$

Solution:

(i) $x^2 = 5$
On solving, we get
$\Rightarrow x = \pm \sqrt{5}$
Hence, x is an irrational number.

(ii) $y^2 = 9$
On solving, we get
$\Rightarrow y = \pm 3$
Hence, y is a rational number.

(iii) $z^2 = .04$
On solving, we get
$\Rightarrow z = \pm 0.2$
Hence, z is a rational number.

(iv) $u^2 = 17/4$
On solving, we get
$\Rightarrow u = \pm \sqrt{17}/2$
$\sqrt{17}$ is irrational.
Hence, u is an irrational number

2. Find three rational numbers between

(i) –1 and –2
(ii) 0.1 and 0.11
(iii) 5/7 and 6/7
(iv) 1/4 and 1/5

Solution:

(i) –1 and –2
Three rational numbers between –1 and –2 are –1.1, –1.2 and –1.3.

(ii) 0.1 and 0.11
Three rational numbers between 0.1 and 0.11 are 0.101, 0.102 and 0.103.

(iii)5/7 and 6/7
5/7 can be written as $(5 \times 10)/(7 \times 10) = 50/70$
Similarly,

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6/7 can be written as (6 × 10)/(7 × 10) = 60/70
Three rational numbers between 5/7 and 6/7 = three rational numbers between 50/70 and 60/70.
Three rational numbers between 5/7 and 6/7 are 51/70, 52/70, 53/70.

(iv)1/4 and 1/5
Here, according to the question,
LCM of 4 and 5 is 20.
Let us make the denominators common, 80.
(4 × 20) = 80 and (5 × 16) = 80
Hence,
1/4 can be written as (1 × 20)/(4 × 20) = 20/80
Similarly,
1/5 can be written as (1 × 16)/(5 × 16) = 16/80
Three rational numbers between 1/4 and 1/5 = three rational numbers between 16/80 and 20/80.
Therefore, the three rational numbers are 17/80, 18/80 and 19/80.

3. Insert a rational number and an irrational number between the following:

(i) 2 and 3
(ii) 0 and 0.1
(iii) 1/3 and 1/2
(iv) – 2/5 and 1/2
(v) 0.15 and 0.16
(vi) √2 and √3
(vii) 2.357 and 3.121
(viii) .0001 and .001
(ix) 3.623623 and 0.484848
(x) 6.375289 and 6.375738.

Solution:

(i) 2 and 3
So, rational number between 2 and 3 = 2.5
And, irrational number between 2 and 3 = 2.040040004...

(ii) 0 and 0.1
So, rational number between 0 and 0.1 = 0.05
And, irrational number between 0 and 0.1 = 0.007000700007…

(iii) 1/3 and 1/2
LCM of 3 and 2 is 6.
1/3 = 0.33
1/3 can be written as (1 × 20)/(3 × 20) = 20/60
½ = 0.5
1/2 can be written as (1 × 30)/(2 × 30) = 30/60
So, rational number between 1/3 and 1/2 = 25/60
And, irrational number between 1/3 and 1/2 = irrational number between 0.33 and 0.5 = 0.414114111...

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(iv) – 2/5 and 1/2
LCM of 5 and 2 is 10.
-2/5 = -0.4
-2/5 can be written as (-2 × 2)/(5 × 2) = -4/10
1/2 = 0.5
1/2 can be written as (1 × 5)/(2 × 5) = 5/10
So, rational number between -2/5 and 1/2 = rational number between -4/10 and 5/10 = 1/10
And, irrational number between -2/5 and 1/2 = irrational number between -0.4 and 0.5 = 0.414114111...

(v) 0.15 and 0.16
Rational number between 0.15 and 0.16 = 0.151
Irrational number between 0.15 and 0.16 = 0.151551555...

(vi) √2 = 1.41 and √3 = 1.732
Rational number between √2 and √3 = rational number between 1.41 and 1.732 = 1.5
Irrational number between √2 and √3 = irrational number between 1.41 and 1.732 = 1.585585558...

(vii) 2.357 and 3.121
Rational number between 2.357 and 3.121 = 3
Irrational number between 2.357 and 3.121 = 3.101101110...

(viii) .0001 and .001
Rational number between .0001 and .001 = 0.00011
Irrational number between .0001 and .001 = 0.0001131331333...

(ix) 3.623623 and 0.484848
Rational number between 3.623623 and 0.484848 = 1
Irrational number between 3.623623 and 0.484848 = 1.909009000...

(x) 6.375289 and 6.375738.
Rational number between 6.375289 and 6.375738 = 6.3753
Irrational number between 6.375289 and 6.375738 = 6.375414114111...

4. Represent the following numbers on the number line:
7, 7.2, –3/2 , –12/5
Solution:

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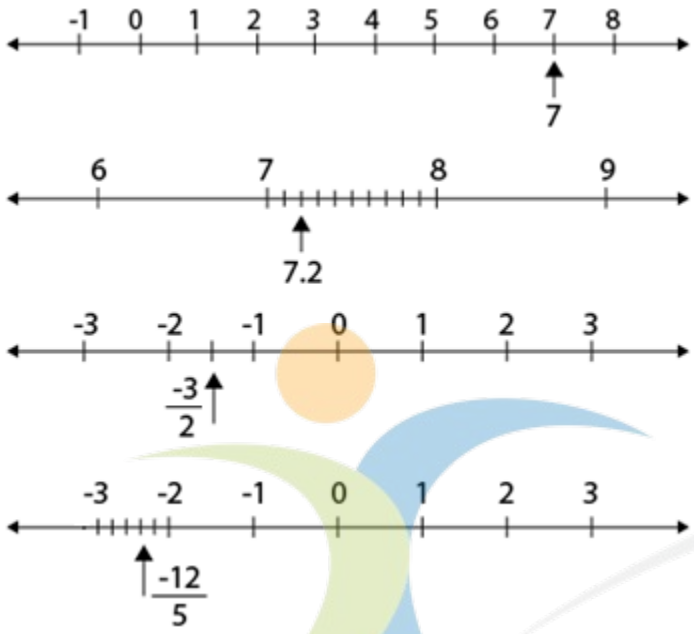
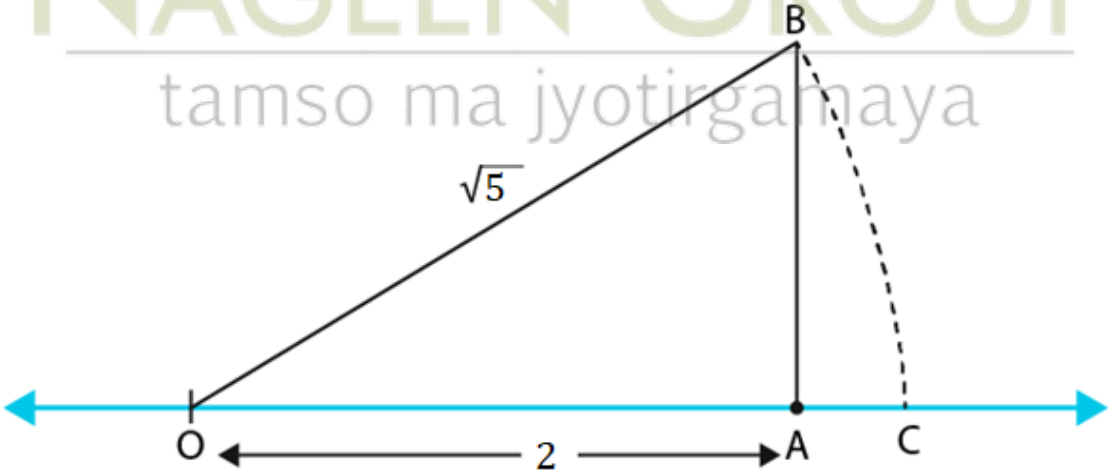


5. Locate √5, √10 and √17 on the number line.

Solution:

√5 on the number line:

5 can be written as the sum of the square of two natural numbers:
i.e., $5 = 1 + 4 = 1^2 + 2^2$
On the number line,
Take OA = 2 units.
Perpendicular to OA, draw BA = 1 unit.
Join OB.
Using Pythagoras theorem,
We have, OB= √5
Draw an arc with centre O and radius OB using a compass such that it intersects the number line at the point C.
Then, we get, C corresponds to √5. Or we can say that OC = √5



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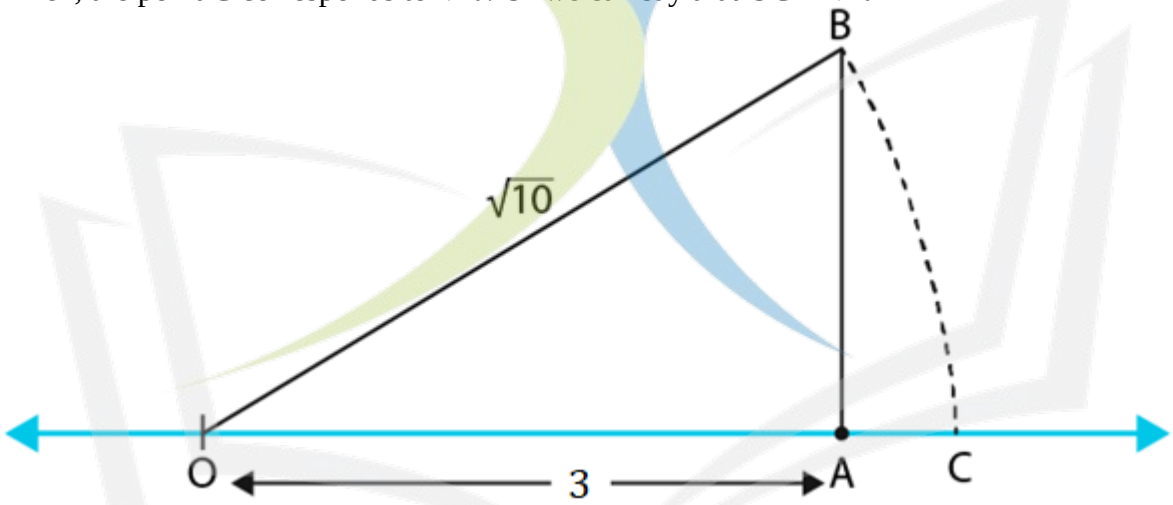
√10 on the number line:

10 can be written as the sum of the square of two natural numbers:
i.e., 10 =1+ 9 =1^2 + 3^2
On the number line,
Take OA = 3 units.
Perpendicular to OA, draw BA = 1 unit.
Join OB.
Using Pythagoras theorem,
We have, OB= √10
Draw an arc with centre O and radius OB using a compass such that it intersects the number line at the point C.
Then, the point C corresponds to √10. Or we can say that OC = √10



√17 on the number line:

17 can be written as the sum of the square of two natural numbers:
i.e., 17 =1+ 16 =1^2 + 4^2
On the number line,
Take OA = 4 units.
Perpendicular to OA, draw BA = 1 unit.
Join OB.
Using Pythagoras theorem,
We have, OB= √17
Draw an arc with centre O and radius OB using a compass such that it intersects the number line at the point C.
Then, the point C corresponds to √17. Or, we can say that OC = √17

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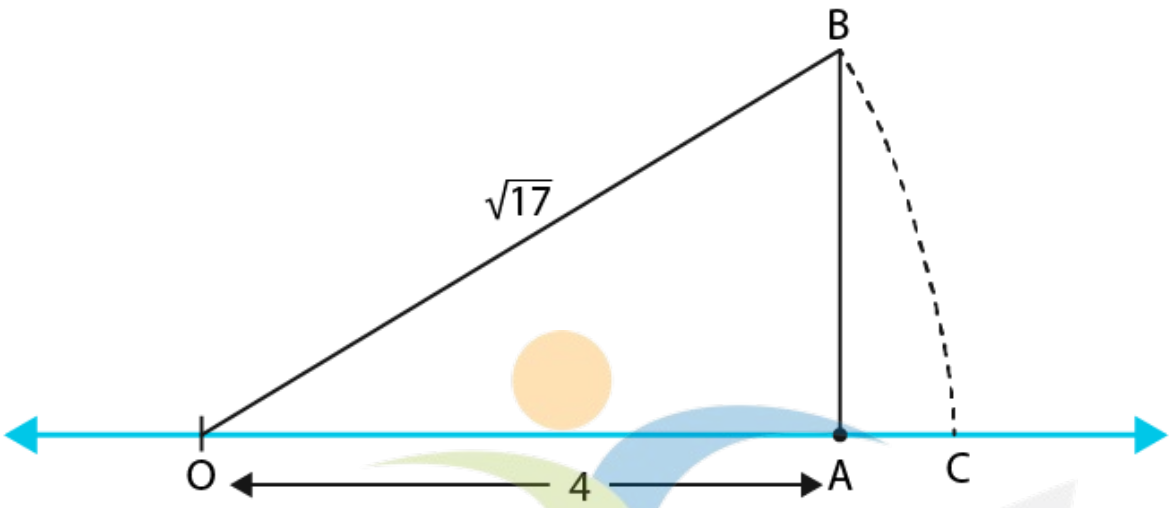
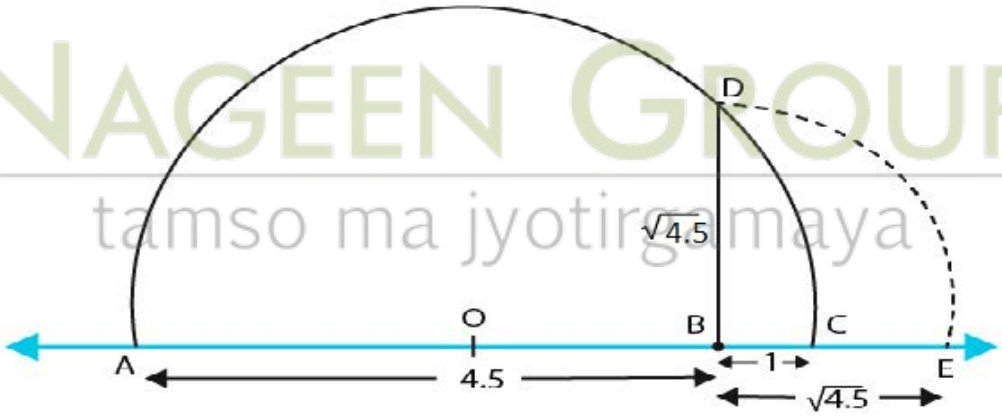


6. Represent geometrically the following numbers on the number line:
(i) √4.5
(ii) √5.6
(iii) √8.1
(iv) √2.3
Solution:

(i) √4.5
Draw a line segment such that AB = 4.5 units.
Mark C at a distance of 1 unit from B.
Mark O, the mid-point of AC.
Draw a semicircle with centre O and radius OC.
Draw a line perpendicular to AC, passing through B and intersecting the semicircle at D.
Now, BD = √4.5.
Draw an arc with centre B and radius BD, meeting AC produced at E.
Then BE = BD = √4.5 units.



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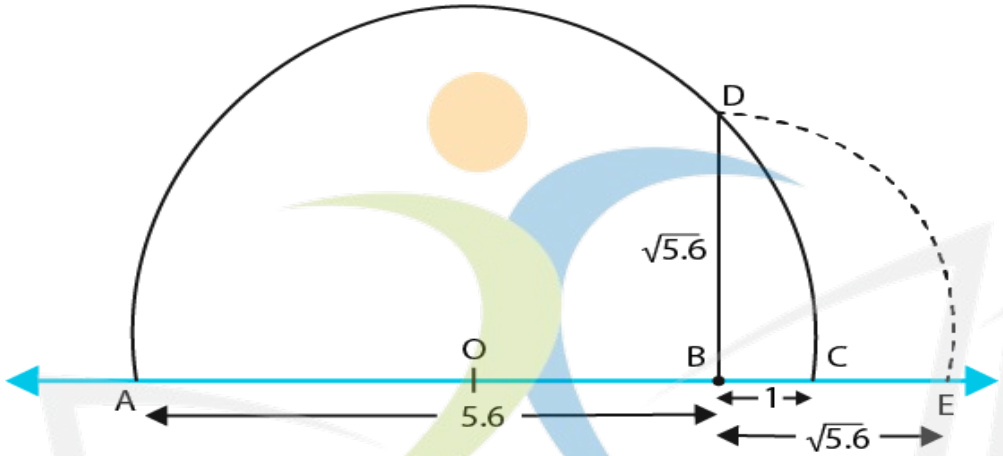
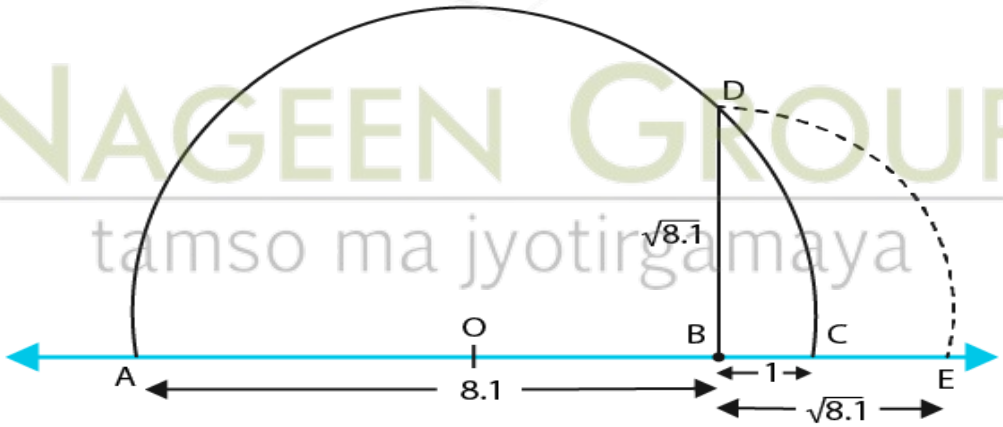
(ii) √5.6
Draw a line segment such that AB = 5.6 units.

Mark C at a distance of 1 unit from B.
Mark O, the mid-point of AC.
Draw a semicircle with centre O and radius OC.
Draw a line perpendicular to AC, passing through B and intersecting the semicircle at D.
Now, BD = √5.6
Draw an arc with centre B and radius BD, meeting AC produced at E.
Then BE = BD = √5.6 units.



(iii) √8.1
Draw a line segment such that AB = 8.1 units.
Mark C at a distance of 1 unit from B.
Mark O, the mid-point of AC.
Draw a semicircle with centre O and radius OC.
Draw a line perpendicular to AC, passing through B and intersecting the semicircle at D.
Now, BD = √8.1.
Draw an arc with centre B and radius BD, meeting AC produced at E.
Then BE = BD = √8.1 units.



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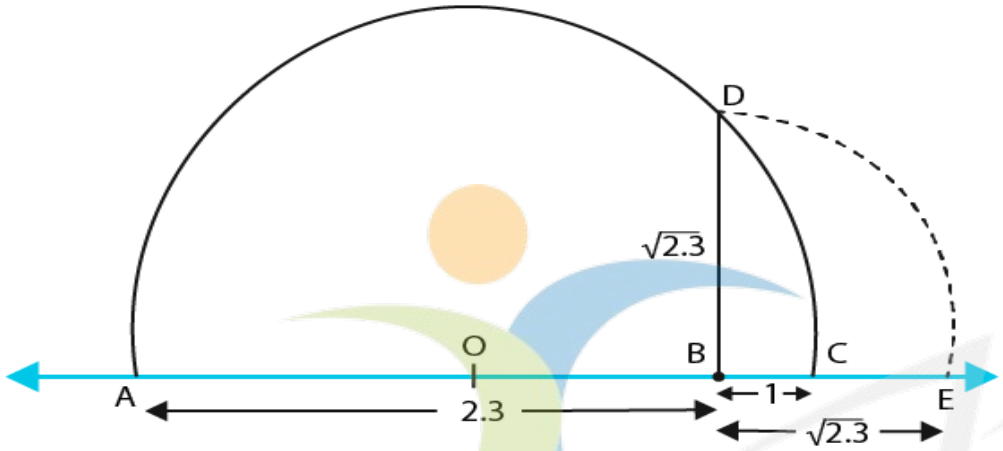
(iv) √2.3
Draw a line segment such that AB = 2.3 units.
Mark C at a distance of 1 unit from B.
Mark O, the mid-point of AC.
Draw a semicircle with centre O and radius OC.

Draw a line perpendicular to AC, passing through B and intersecting the semicircle at D.
Now, BD = $\sqrt{2.3}$.
Draw an arc with centre B and radius BD, meeting AC produced at E.
Then BE = BD = $\sqrt{2.3}$ units.



7. Express the following in the form p/q, where p and q are integers and q ≠ 0 :
(i) 0.2
(ii) 0.888...
(iii) $5.\overline{2}$
(iv) $0.\overline{001}$
(v) 0.2555...
(vi) $0.1\overline{34}$
(vii) .00323232...
(viii) .404040...
Solution:

(i) 0.2

We know that,
0/2 can be written as,
0.2 = 2/10 = 1/5

(ii) 0.888...

Assume that x = 0.888 …
⇒ x = 0.8 ……. Eq.(1)
Multiply L.H.S and R.H.S by 10,
We get
10 x = 8.8 ……. Eq.(2)
Subtracting equation (1) from (2),
We get
10 x − x = 8.8 − 0.8
⇒ 9x = 8
⇒ x = 8/9

(iii) $5.\overline{2}$

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Assume that $x = 5.2$ ……. Eq.(1)
Multiply L.H.S and R.H.S by 10,
We get
$10x = 52.2$ …… Eq. (2)
Subtracting equation (1) from (2),
We get
$10x - x = 52.2 - 5.2$
$\Rightarrow 9x = 47$
$\Rightarrow x = 47/9$

(iv) $0.\overline{001}$

Assume that $x = 0.001$ ……. Eq. (1)
Multiply L.H.S and R.H.S by 1000,
We get
$1000x = 1.001$ …… Eq. (2)
Subtracting equation (1) from (2),
We get
$1000x - x = 1.001 - 0.001$
$\Rightarrow 999x = 1$
$\Rightarrow x = 1/999$

(v) 0.2555...

Assume that $x = 0.2555$ …
$\Rightarrow x = 0.25$ ……. Eq. (1)
Multiply L.H.S and R.H.S by 10,
We get
$10x = 2.5$ ……. Eq. (2)
Multiply L.H.S and R.H.S by 100,
We get
$100x = 25.5$ ……. Eq. (3)
Subtracting equation (2) from (3),
We get
$100x - 10x = 25.5 - 2.5$
$\Rightarrow 90x = 23$
$\Rightarrow x = 23/90$

(vi) $0.1\overline{34}$

Let $x = 0.134$ ……. Eq. (1)
Multiply L.H.S and R.H.S by 10,
We get
$10x = 1.34$ ……. Eq. (2)
Multiply L.H.S and R.H.S by 1000,
We get
$1000x = 134.34$ ……. Eq. (3)
Subtracting equation (2) from (3),

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We get
$1000\,x - 10x = 134.34 - 1.34$
$\Rightarrow 990x = 133$
$\Rightarrow x = 133/990$

(vii) .00323232...

Let $x = 0.00323232\ldots$
$\Rightarrow x = 0.0032$ …… Eq. (1)
Multiply L.H.S and R.H.S by 100,
We get,
$100x = 0.32$ …… Eq. (2)
Multiply L.H.S and R.H.S by 10000,
We get
$10000\,x = 32.32$ …… Eq. (3)
Subtracting equation (2) from (3),
We get
$10000\,x - 100x = 32.32 - 0.32$
$\Rightarrow 9900x = 32$
$\Rightarrow x = 32/9900 = 8/2475$

(viii) .404040...

Let $x = 0.404040\ldots$
$\Rightarrow x = 0.40$ …… (1)
Multiply L.H.S and R.H.S by 100,
We get
$100\,x = 40.40$ …… (2)
Subtracting equation (1) from (2),
We get
$100\,x - x = 40.40 - 0.40$
$\Rightarrow 99x = 40$
$\Rightarrow x = 40/99$

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EXERCISE 1.4

1. Express $0.6+0.\overline{7}+0.4\overline{7}$ in the form p/q, where *p* and *q* are integers and $q \neq 0$.

Solution:

Let x = 0.6

Multiply by 10 on L.H.S and R.H.S,

10x = 6

x = 6/10

x = 3/5

So, the p/q form of 0.6 = 3/5

Let y = 0.77777…

Multiply by 10 on L.H.S and R.H.S,

10y = 7.7777…

10y – y = 7.7777777……. – 0.7777777……..

9y = 7

y = 7/9

So the p/q form of 0.7777… = 7/9

Let z = 0.47777…

Multiply by 10 on L.H.S and R.H.S,

10z = 4.7777…

10z – z = 4.7777777… – 0.47777777…

9z = 4.2999

z ≈ 4.3/9

z = 43/90

So the p/q form of 0.4777… = 43/90

Therefore, p/q form of $0.6+0.\overline{7}+0.4\overline{7}$ is,

x+y+z = 3/5 + 7/9 + 43/90

= (54 + 70 + 43)/90

= 167/90

2. Simplify:

$$\frac{7\sqrt{3}}{\sqrt{10}+\sqrt{3}}-\frac{2\sqrt{5}}{\sqrt{6}+5}-\frac{3\sqrt{2}}{\sqrt{15}+3\sqrt{2}}$$

Solution:

$$\frac{7\sqrt{3}}{\sqrt{10}+\sqrt{3}}-\frac{2\sqrt{5}}{\sqrt{6}+5}-\frac{3\sqrt{2}}{\sqrt{15}+3\sqrt{2}}$$

Let us first make the denominators same,

To make the denominators same, Cross multiply the first and second terms of the equation.

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$$\Rightarrow \frac{7\sqrt{3} \times (\sqrt{6} + \sqrt{5}) - (\sqrt{10} + \sqrt{3}) \times 2\sqrt{5}}{(\sqrt{10} + \sqrt{3}) \times (\sqrt{6} + \sqrt{5})} - \frac{3\sqrt{2}}{\sqrt{15} + 3\sqrt{2}}$$

$$\Rightarrow \frac{7\sqrt{3} \times \sqrt{6} + 7\sqrt{3} \times \sqrt{5} - (2\sqrt{5} \times \sqrt{10} + 2\sqrt{5} \times \sqrt{3})}{(\sqrt{10} + \sqrt{3}) \times (\sqrt{6} + \sqrt{5})} - \frac{3\sqrt{2}}{\sqrt{15} + 3\sqrt{2}}$$

$$\Rightarrow \frac{21\sqrt{2} + 7\sqrt{15} - 10\sqrt{2} - 2\sqrt{15}}{2\sqrt{15} + 5\sqrt{2} + 3\sqrt{2} + \sqrt{15}} - \frac{3\sqrt{2}}{\sqrt{15} + 3\sqrt{2}}$$

$$\Rightarrow \frac{11\sqrt{2} - 5\sqrt{15}}{3\sqrt{15} + 8\sqrt{2}} - \frac{3\sqrt{2}}{\sqrt{15} + 3\sqrt{2}}$$

Now, again make the denominators same by cross-multiplying the obtained term and the third term of the given equation in the question.

$$\Rightarrow \frac{(11\sqrt{2} - 5\sqrt{15}) \times (\sqrt{15} + 3\sqrt{2}) - (3\sqrt{15} + 8\sqrt{2}) \times (3\sqrt{2})}{(3\sqrt{15} + 8\sqrt{2}) \times \sqrt{15} + 3\sqrt{2}}$$

$$\Rightarrow \frac{11\sqrt{30} + 66 - 75 - 15\sqrt{30} - 9\sqrt{30} - 48}{45 + 9\sqrt{30} + 8\sqrt{30} + 48}$$

$$\Rightarrow \frac{-13\sqrt{30} - 57}{17\sqrt{30} + 93}$$

3. If $\sqrt{2}$ =1.414, $\sqrt{3}$ =1.732, then find the value of

$$\frac{4}{3\sqrt{3} - 2\sqrt{2}} + \frac{3}{3\sqrt{3} + 2\sqrt{2}}$$

Solution:

$$\frac{4}{3\sqrt{3} - 2\sqrt{2}} + \frac{3}{3\sqrt{3} + 2\sqrt{2}}$$

Let us first make the denominators same by cross multiplication method

$$\Rightarrow \frac{4 \times (3\sqrt{3} + 2\sqrt{2}) + 3 \times (3\sqrt{3} - 2\sqrt{2})}{(3\sqrt{3} - 2\sqrt{2}) \times (3\sqrt{3} + 2\sqrt{2})}$$

Observing the denominator, we can say that,
Denominators is of the form,
$(a + b) \times (a - b) = (a^2 - b^2)$
Here $a = 3\sqrt{3}$
$b = 2\sqrt{2}$

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$a^2 = (3\sqrt{3})^2 = 27$
$b^2 = (2\sqrt{2})^2 = 8$

$$\Rightarrow \frac{12\sqrt{3} + 8\sqrt{2} + 9\sqrt{3} - 6\sqrt{2}}{27 - 8}$$

$$\Rightarrow \frac{21\sqrt{3} + 2\sqrt{2}}{19}$$

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Chapter – 1

Number system

Exercise 1.1

Question 1:

Is zero a rational number? Can you write it in the form $\frac{p}{q}$, where p and q are integers and $q \neq 0$?

Answer:

Yes. Zero is a rational number as it can be represented as $\frac{0}{1}$ or $\frac{0}{2}$ or $\frac{0}{3}$ etc.

Question 2:

Find six rational numbers between 3 and 4.

Answer:

There are infinite rational numbers in between 3 and 4.

3 and 4 can be represented as $\frac{24}{8}$ and $\frac{32}{8}$ respectively.

Therefore, rational numbers between 3 and 4 are

$\frac{25}{8}, \frac{26}{8}, \frac{27}{8}, \frac{28}{8}, \frac{29}{8}, \frac{30}{8}$

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Question 3:

Find five rational numbers between $\frac{3}{5}$ and $\frac{4}{5}$.

Answer:

There are infinite rational numbers between $\frac{3}{5}$ and $\frac{4}{5}$.

$$\frac{3}{5}=\frac{3\times6}{5\times6}=\frac{18}{30}$$
$$\frac{4}{5}=\frac{4\times6}{5\times6}=\frac{24}{30}$$

Therefore, rational numbers between are $\frac{3}{5}$ and $\frac{4}{5}$

$$\frac{19}{30},\frac{20}{30},\frac{21}{30},\frac{22}{30},\frac{23}{30}$$

Question 4:

State whether the following statements are true or false. Give reasons for your

Answers.

(i) Every natural number is a whole number.

(ii) Every integer is a whole number.

(iii) Every rational number is a whole number.

Answer:

(i) True; since the collection of whole numbers contains all natural numbers.

(ii) False; as integers may be negative but whole numbers are positive. For example: −3 is an integer but not a whole number.

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Exercise 1.2

Question 1:

State whether the following statements are true or false. Justify your **Answer**s.

(i) Every irrational number is a real number.

(ii) Every point on the number line is of the form $\sqrt{m}$, where *m* is a natural number.

(iii) Every real number is an irrational number.

Answer:

(i) True; since the collection of real numbers is made up of rational and irrational numbers.

(ii) False; as negative numbers cannot be expressed as the square root of any other number.

(iii) False; as real numbers include both rational and irrational numbers. Therefore, every real number cannot be an irrational number.

Question 2:

Are the square roots of all positive integer's irrational? If not, give an example of the square root of a number that is a rational number.

Answer:

If numbers such as $\sqrt{4}=2,\ \sqrt{9}=3$ are considered,

Then here, 2 and 3 are rational numbers. Thus, the square roots of all positive integers are not irrational.

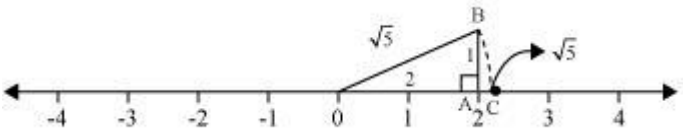
Question 3:

Show how $\sqrt{5}$ can be represented on the number line.

Answer:

We know that, $\sqrt{4}=2$

And, $\sqrt{5}=\sqrt{(2)^2+(1)^2}$



Mark a point 'A' representing 2 on number line. Now, construct AB of unit length perpendicular to OA. Then, taking O as centre and OB as radius, draw

an arc intersecting number line at C.

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C is representing $\sqrt{5}$.

Question :4 Classroom activity (Constructing the 'square root spiral') :

Take a large sheet of paper and construct the 'square root spiral' in the following fashion. Start with a point O and draw a line segment P1P2 perpendicular to OP1 of unit length (see Fig. 1.9). Now draw a line segment P2P3 perpendicular to OP2. Then draw a line segment P3P4 perpendicular to OP3. Continuing in this manner, you can get the line segment Pn-1Pn by drawing a line segment of unit length perpendicular to OPn-1. In this manner, you will have created the points P2,P3,……,Pn……, and joined them to create a beautiful spiral depicting

Answer : Activity

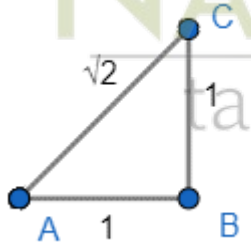
For the square root spiral follow the given steps:-

1. Draw a line AB of length 1 unit.

2. Draw another line BC of length 1 unit perpendicular to AB.

3. Now, Join point A and point C forming a line AC.

Here, AC represents a line of length √2 units.(This can be easily found using Pythagoras Theorem in right ΔABC)



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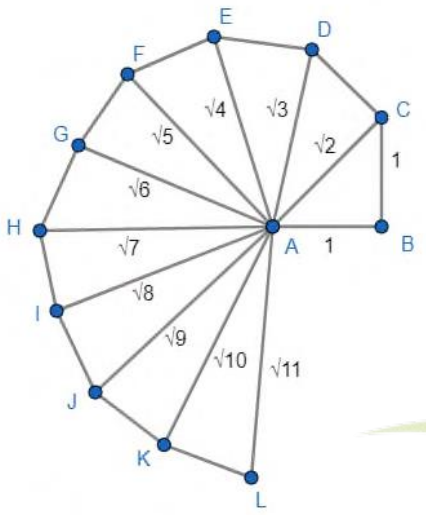
4. Now, Draw a perpendicular CD of length 1 unit at point C and join points A and D.AD here represents length √3.

5. Similarly proceeding further we get Square Root Spiral.



Exercise 1.3

Question 1:

Write the following in decimal form and say what kind of decimal expansion each has:

(i) $\frac{36}{100}$ (ii) $\frac{1}{11}$ (iii) $4\frac{1}{8}$

(iv) $\frac{3}{13}$ (v) $\frac{2}{11}$ (vi) $\frac{329}{400}$

Answer:

(i) $\frac{36}{100} = 0.36$

Terminating

(ii) $\frac{1}{11} = 0.090909..... = 0.\overline{09}$

Non-terminating repeating

(iii) $4\frac{1}{8} = \frac{33}{8} = 4.125$

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Terminating

(iv) $\frac{3}{13} = 0.230769230769.... = 0.\overline{230769}$

Non-terminating repeating

(v) $\frac{2}{11} = 0.18181818..... = 0.\overline{18}$

Non-terminating repeating

(vi) $\frac{329}{400} = 0.8225$

Terminating

Question 2:

You know that $\frac{1}{7} = 0.\overline{142857}$. Can you predict what the decimal expansion of $\frac{2}{7}, \frac{3}{7}, \frac{4}{7}, \frac{5}{7}, \frac{6}{7}$ are, without actually doing the long division? If so, how?

[**Hint:** Study the remainders while finding the value of $\frac{1}{7}$ carefully.]

Answer:

Yes. It can be done as follows.

$\frac{2}{7} = 2 \times \frac{1}{7} = 2 \times 0.\overline{142857} = 0.\overline{285714}$

$\frac{3}{7} = 3 \times \frac{1}{7} = 3 \times 0.\overline{142857} = 0.\overline{428571}$

$\frac{4}{7} = 4 \times \frac{1}{7} = 4 \times 0.\overline{142857} = 0.\overline{571428}$

$\frac{5}{7} = 5 \times \frac{1}{7} = 5 \times 0.\overline{142857} = 0.\overline{714285}$

$\frac{6}{7} = 6 \times \frac{1}{7} = 6 \times 0.\overline{142857} = 0.\overline{857142}$

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Question 3:

Express the following in the form $\frac{p}{q}$, where p and q are integers and $q \neq 0$.

(i) $0.\overline{6}$ (ii) $0.4\overline{7}$ (iii) $0.\overline{001}$

Answer:

(i) $0.\overline{6} = 0.666...$

Let $x = 0.666...$

$10x = 6.666...$

$10x = 6 + x$

$9x = 6$

$$x = \frac{2}{3}$$

(ii) $0.\overline{47} = 0.4777.....$

$$= \frac{4}{10} + \frac{0.777}{10}$$

Let $x = 0.777...$

$10x = 7.777...$

$10x = 7 + x$

$$x = \frac{7}{9}$$

$$\frac{4}{10} + \frac{0.777...}{10} = \frac{4}{10} + \frac{7}{90}$$

$$= \frac{36+7}{90} = \frac{43}{90}$$

(iii) $0.\overline{001} = 0.001001...$

Let $x = 0.001001...$

$1000x = 1.001001...$

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$1000x = 1 + x$

$999x = 1$

$$x = \frac{1}{999}$$

Question 4:

Express 0.99999…in the form $\frac{p}{q}$. Are you surprised by your **Answer**? With your teacher and classmates discuss why the **Answer** makes sense.

Answer:

Let $x = 0.9999\ldots$

$10x = 9.9999\ldots$

$10x = 9 + x$

$9x = 9$

$x = 1$

Question 5:

What can the maximum number of digits be in the repeating block of digits in the decimal expansion of $\frac{1}{17}$? Perform the division to check your **Answer**.

Answer:

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It can be observed that,

$$\frac{1}{17} = 0.\overline{0588235294117647}$$

There are 16 digits in the repeating block of the decimal expansion of $\frac{1}{17}$.

Question 6:

Look at several examples of rational numbers in the form $\frac{p}{q}$ ($q \neq 0$), where p and q are integers with no common factors other than 1 and having terminating decimal representations (expansions). Can you guess what property q must satisfy?

Answer:

Terminating decimal expansion will occur when denominator q of rational number $\frac{p}{q}$ is either of 2, 4, 5, 8, 10, and so on…

$\frac{9}{4} = 2.25$

$\frac{11}{8} = 1.375$

$\frac{27}{5} = 5.4$

It can be observed that terminating decimal may be obtained in the situation where prime factorisation of the denominator of the given fractions has the power of 2 only or 5 only or both.

Question 7:

Write three numbers whose decimal expansions are non-terminating non-recurring.

Answer:

3 numbers whose decimal expansions are non-terminating non-recurring are as follows.

0.505005000500005000005…

0.72072007200072000072000000…

0.0800800080000800000800000008…

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Question 8:

Find three different irrational numbers between the rational numbers $\frac{5}{7}$ and $\frac{9}{11}$.

Answer:

$\frac{5}{7} = 0.\overline{714285}$

$\frac{9}{11} = 0.\overline{81}$

3 irrational numbers are as follows.

0.73073007300073000073…

0.75075007500075000075…

0.79079007900079000079…

Question 9:

Classify the following numbers as rational or irrational:

(i) $\sqrt{23}$ (ii) $\sqrt{225}$ (iii) 0.3796

(iv) 7.478478 (v) 1.101001000100001…

Answer:

(i) $\sqrt{23} = 4.79583152331\ldots$

As the decimal expansion of this number is non-terminating non-recurring, therefore, it is an irrational number.

(ii) $\sqrt{225} = 15 = \frac{15}{1}$

It is a rational number as it can be represented in $\frac{p}{q}$ form.

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(iii) 0.3796

As the decimal expansion of this number is terminating, therefore, it is a rational number.

(iv) 7.478478 … $= 7.\overline{478}$

As the decimal expansion of this number is non-terminating recurring, therefore, it is a rational number.

(v) 1.10100100010000 …

As the decimal expansion of this number is non-terminating non-repeating, therefore, it is an irrational number.

Exercise 1.4

Question 1:

Classify the following numbers as rational or irrational:

(i) $2-\sqrt{5}$ (ii) $\left(3+\sqrt{23}\right)-\sqrt{23}$ (iii) $\frac{2\sqrt{7}}{7\sqrt{7}}$

(iv) $\frac{1}{\sqrt{2}}$ (v) 2π

Answer:

(i) $2-\sqrt{5}$ = 2 – 2.2360679…

= – 0.2360679…

As the decimal expansion of this expression is non-terminating non-recurring, therefore, it is an irrational number.

(ii) $\left(3+\sqrt{23}\right)-\sqrt{23}=3=\frac{3}{1}$

As it can be represented in $\frac{p}{q}$ form, therefore, it is a rational number.

(iii) $\frac{2\sqrt{7}}{7\sqrt{7}}=\frac{2}{7}$

As it can be represented in $\frac{p}{q}$ form, therefore, it is a rational number.

(iv) $\frac{1}{\sqrt{2}}=\frac{\sqrt{2}}{2}=0.7071067811...$

As the decimal expansion of this expression is non-terminating non-recurring, therefore, it is an irrational number.

(v) 2π = 2(3.1415 …)

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= 6.2830 …

As the decimal expansion of this expression is non-terminating non-recurring, therefore, it is an irrational number.

Question 2:

Simplify each of the following expressions:

(i) $(3+\sqrt{3})(2+\sqrt{2})$ (ii) $(3+\sqrt{3})(3-\sqrt{3})$

(iii) $(\sqrt{5}+\sqrt{2})^2$ (iv) $(\sqrt{5}-\sqrt{2})(\sqrt{5}+\sqrt{2})$

Answer:

(i) $(3+\sqrt{3})(2+\sqrt{2}) = 3(2+\sqrt{2})+\sqrt{3}(2+\sqrt{2})$

$= 6+3\sqrt{2}+2\sqrt{3}+\sqrt{6}$

(ii) $(3+\sqrt{3})(3-\sqrt{3}) = (3)^2-(\sqrt{3})^2$

= 9 − 3 = 6

(iii) $(\sqrt{5}+\sqrt{2})^2 = (\sqrt{5})^2+(\sqrt{2})^2+2(\sqrt{5})(\sqrt{2})$

$= 5+2+2\sqrt{10} = 7+2\sqrt{10}$

(iv) $(\sqrt{5}-\sqrt{2})(\sqrt{5}+\sqrt{2}) = (\sqrt{5})^2-(\sqrt{2})^2$

= 5 − 2 = 3

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Question 3:

Recall, π is defined as the ratio of the circumference (say *c*) of a circle to its diameter (say *d*). That is, $\pi = \frac{c}{d}$. This seems to contradict the fact that π is irrational. How will you resolve this contradiction?

Answer:

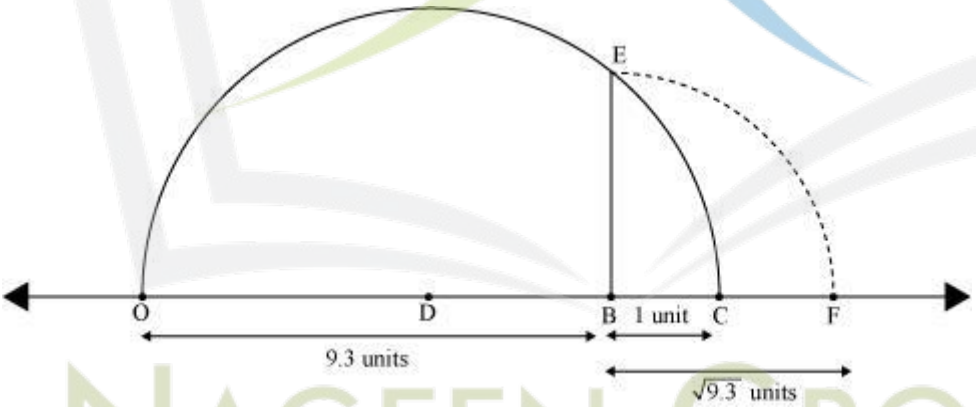
There is no contradiction. When we measure a length with scale or any other instrument, we only obtain an approximate rational value. We never obtain an exact value. For this reason, we may not realise that either *c* or *d* is irrational. Therefore, the fraction $\frac{c}{d}$ is irrational. Hence, π is irrational.

Question 4:

Represent $\sqrt{9.3}$ on the number line.

Answer:

Mark a line segment OB = 9.3 on number line. Further, take BC of 1 unit. Find the mid-point D of OC and draw a semi-circle on OC while taking D as its centre. Draw a perpendicular to line OC passing through point B. Let it intersect the semi-circle at E. Taking B as centre and BE as radius, draw an arc intersecting number line at F. BF is $\sqrt{9.3}$.



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Question 5:

Rationalise the denominators of the following:

(i) $\frac{1}{\sqrt{7}}$ (ii) $\frac{1}{\sqrt{7}-\sqrt{6}}$

(iii) $\frac{1}{\sqrt{5}+\sqrt{2}}$ (iv) $\frac{1}{\sqrt{7}-2}$

Answer:

(i) $\frac{1}{\sqrt{7}} = \frac{1 \times \sqrt{7}}{1 \times \sqrt{7}} = \frac{\sqrt{7}}{7}$

(ii) $\frac{1}{\sqrt{7}-\sqrt{6}} = \frac{1 \quad (\sqrt{7}+\sqrt{6})}{(\sqrt{7}-\sqrt{6})(\sqrt{7}+\sqrt{6})}$

$= \frac{\sqrt{7}+\sqrt{6}}{(\sqrt{7})^2-(\sqrt{6})^2}$

$= \frac{\sqrt{7}+\sqrt{6}}{7-6} = \frac{\sqrt{7}+\sqrt{6}}{1} = \sqrt{7}+\sqrt{6}$

(iii) $\frac{1}{\sqrt{5}+\sqrt{2}} = \frac{1 \quad (\sqrt{5}-\sqrt{2})}{(\sqrt{5}+\sqrt{2})(\sqrt{5}-\sqrt{2})}$

$= \frac{\sqrt{5}-\sqrt{2}}{(\sqrt{5})^2-(\sqrt{2})^2} = \frac{\sqrt{5}-\sqrt{2}}{5-2}$

$= \frac{\sqrt{5}-\sqrt{2}}{3}$

(iv) $\frac{1}{\sqrt{7}-2} = \frac{1 \quad (\sqrt{7}+2)}{(\sqrt{7}-2)(\sqrt{7}+2)}$

$= \frac{\sqrt{7}+2}{(\sqrt{7})^2-(2)^2}$

$= \frac{\sqrt{7}+2}{7-4} = \frac{\sqrt{7}+2}{3}$

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Exercise 1.5

Question 1:

Find:

(i) $64^{\frac{1}{2}}$ (ii) $32^{\frac{1}{5}}$ (iii) $125^{\frac{1}{3}}$

Answer:

(i)

$$64^{\frac{1}{2}} = \left(2^6\right)^{\frac{1}{2}}$$
$$= 2^{6\times\frac{1}{2}} \qquad \left[\left(a^m\right)^n = a^{mn}\right]$$
$$= 2^3 = 8$$

(ii)

$$32^{\frac{1}{5}} = \left(2^5\right)^{\frac{1}{5}}$$
$$= (2)^{5\times\frac{1}{5}} \qquad \left[\left(a^m\right)^n = a^{mn}\right]$$
$$= 2^1 = 2$$

(iii)

$$(125)^{\frac{1}{3}} = \left(5^3\right)^{\frac{1}{3}}$$
$$= 5^{3\times\frac{1}{3}} \qquad \left[\left(a^m\right)^n = a^{mn}\right]$$
$$= 5^1 = 5$$

Question 2:

Q2. Find:

(i) $9^{\frac{3}{2}}$ (ii) $32^{\frac{2}{5}}$ (iii) $16^{\frac{3}{4}}$

(iv) $125^{\frac{-1}{3}}$

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Answer:

(i)

$$9^{\frac{3}{2}} = \left(3^2\right)^{\frac{3}{2}}$$
$$= 3^{2\times\frac{3}{2}} \qquad \left[\left(a^m\right)^n = a^{mn}\right]$$
$$= 3^3 = 27$$

(ii)

$$(32)^{\frac{2}{5}} = (2^5)^{\frac{2}{5}}$$
$$= 2^{5\times\frac{2}{5}} \qquad \left[(a^m)^n = a^{mn}\right]$$
$$= 2^2 = 4$$

(iii)

$$(16)^{\frac{3}{4}} = (2^4)^{\frac{3}{4}}$$
$$= 2^{4\times\frac{3}{4}} \qquad \left[(a^m)^n = a^{mn}\right]$$
$$= 2^3 = 8$$

(iv)

$$(125)^{\frac{-1}{3}} = \frac{1}{(125)^{\frac{1}{3}}} \qquad \left[a^{-m} = \frac{1}{a^m}\right]$$
$$= \frac{1}{(5^3)^{\frac{1}{3}}}$$
$$= \frac{1}{5^{3\times\frac{1}{3}}} \qquad \left[(a^m)^n = a^{mn}\right]$$
$$= \frac{1}{5}$$

Question 3:

Simplify:

(i) $2^{\frac{2}{3}}.2^{\frac{1}{5}}$ (ii) $\left(\frac{1}{3^3}\right)^7$ (iii) $\frac{11^{\frac{1}{2}}}{11^{\frac{1}{4}}}$

(iv) $7^{\frac{1}{2}}.8^{\frac{1}{2}}$

Answer:

(i)

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$$2^{\frac{2}{3}}.2^{\frac{1}{5}} = 2^{\frac{2}{3}+\frac{1}{5}} \qquad \left[a^m.a^n = a^{m+n}\right]$$
$$= 2^{\frac{10+3}{15}} = 2^{\frac{13}{15}}$$

(ii)

$$\left(\frac{1}{3^3}\right)^7 = \frac{1}{3^{3\times 7}} \qquad \left[\left(a^m\right)^n = a^{mn}\right]$$
$$= \frac{1}{3^{21}}$$
$$= 3^{-21} \qquad \left[\frac{1}{a^m} = a^{-m}\right]$$

(iii)

$$\frac{11^{\frac{1}{2}}}{11^{\frac{1}{4}}} = 11^{\frac{1}{2}-\frac{1}{4}} \qquad \left[\frac{a^m}{a^n} = a^{m-n}\right]$$
$$= 11^{\frac{2-1}{4}} = 11^{\frac{1}{4}}$$

(iv)

$$7^{\frac{1}{2}}.8^{\frac{1}{2}} = (7\times 8)^{\frac{1}{2}} \qquad [a^m.b^m = (ab)^m]$$
$$= (56)^{\frac{1}{2}}$$

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Class 9th Mathematics

01

NUMBER SYSTEM

MIND MAP

Term	Rationalising factor
$\frac{1}{\sqrt{r}}$	$\sqrt{r}$
$\frac{1}{\sqrt{r}-s}$	$\sqrt{r}+s$
$\frac{1}{\sqrt{r}+s}$	$\sqrt{r}-s$
$\frac{1}{\sqrt{r}-\sqrt{s}}$	$\sqrt{r}+\sqrt{s}$
$\frac{1}{\sqrt{r}+\sqrt{s}}$	$\sqrt{r}-\sqrt{s}$

Product law	$a^m a^n = a^{m+n}$
Quotient law	$a^m \div a^n = a^{m-n}$
Power law	$(a^m)^n = a^{mn}$
Reciprocal law	$\left(\frac{a}{b}\right)^{-m} = \left(\frac{b}{a}\right)^m$

Every point on the line represents real numbers

Transform denominator into a rational number

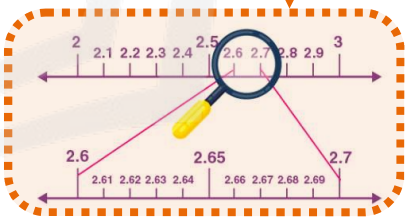
Exponents With Integrals Power

Number line

Rationalization

Number System

Successive magnification



$$a = (b)^{1/n}$$
a, b − real numbers
n − +ve integer

Real number

Nth root of real number

Irrational number (Q)

Rational number (Q)

Integers (Z)

Square root

Cube root

Can not be written in p/q form

Form $\frac{p}{q}$
$q \neq 0, (p,q) \in z$

−∞... −3 −, 2,−1,0,1,2,3 . . .∞

$\sqrt{x} = x^{1/2}$
Example $\sqrt{5}, \sqrt{7}$

Whole numbers (W)

Natural numbers (N)

$\sqrt[3]{x} = (x)^{1/3}$
Example $\sqrt[3]{7}, \sqrt[3]{4}$

Examples $\sqrt{2}, \sqrt{3}$

0,1,2,3...∞

1,2,3...

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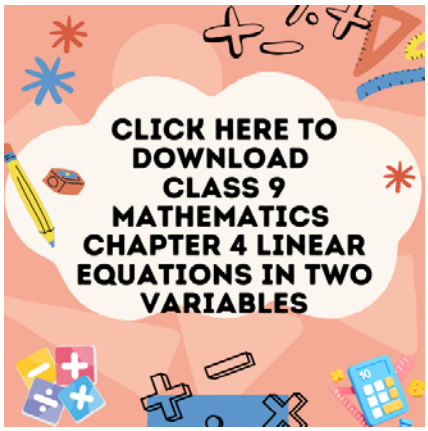

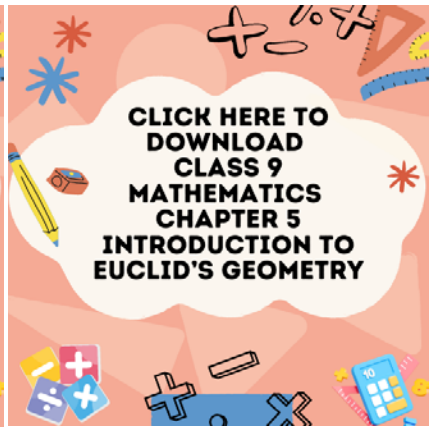

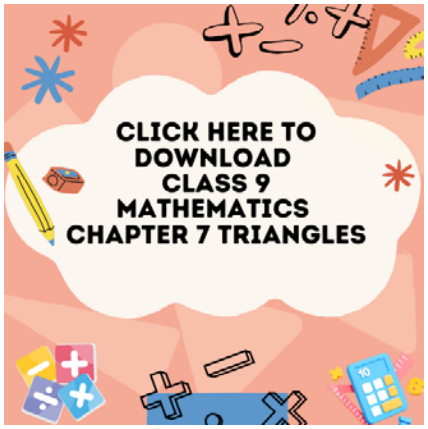

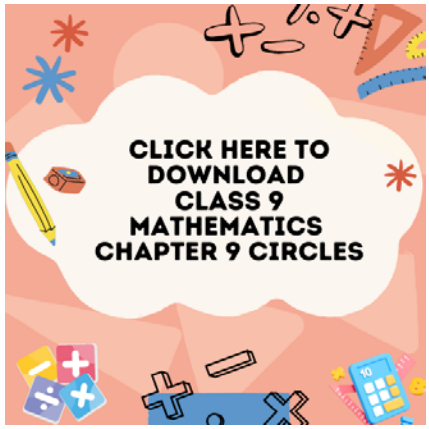

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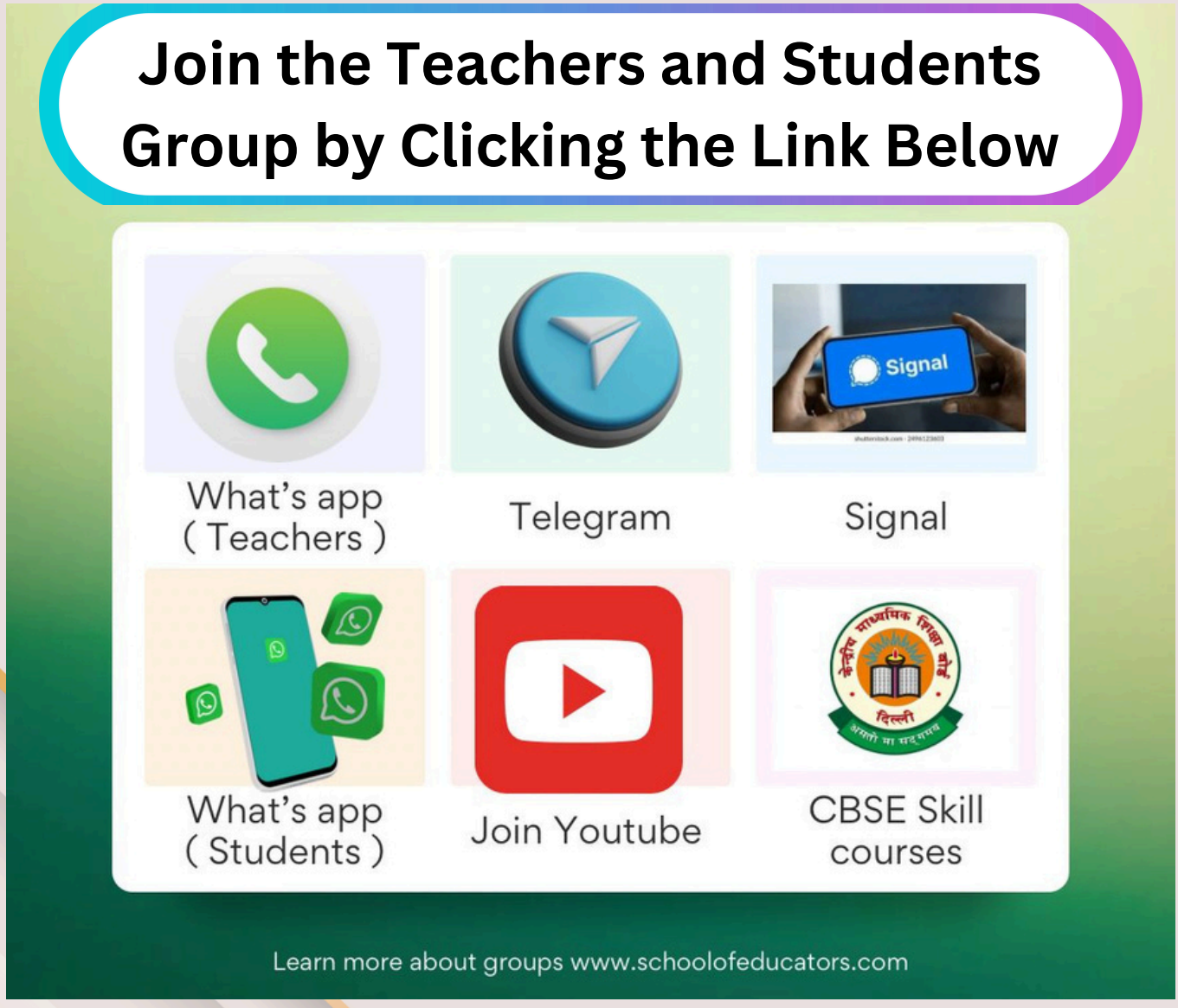
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Class 3

Class 4

Class 5

Class 6

Class 7

Class 8

Class 9

Class 10

Class 11 (Science)

Class 11 (Humanities)

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Class 11 (Science)

Class 11 (Humanities)

Class 11 (Commerce)

Class 12 (Science)

Class 12 (Humanities)

Class 12 (Commerce)

Artificial Intelligence
(VI TO VIII)

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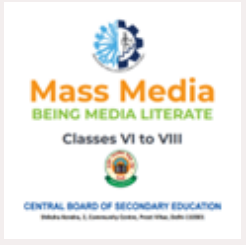
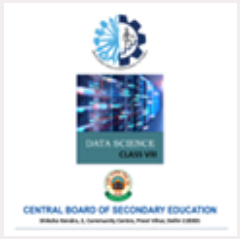


Mass Media - Being Media Literate

Travel & Tourism

Coding



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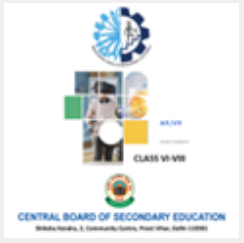
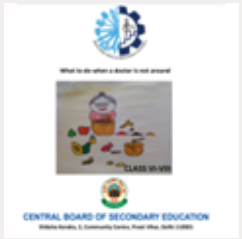


Augmented Reality / Virtual Reality

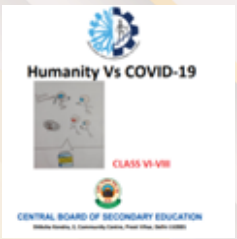
Digital Citizenship

Life Cycle of Medicine & Vaccine

Things you should know about keeping Medicines at home

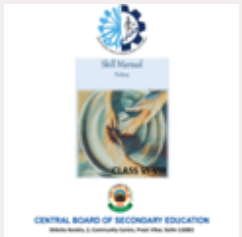


What to do when Doctor is not around



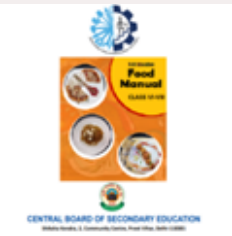
Humanity & Covid-19

Blue Pottery

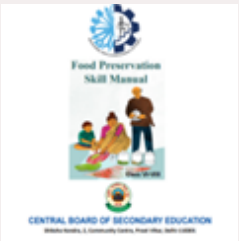


Pottery

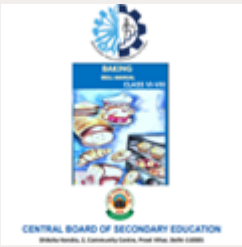
Block Printing



Food



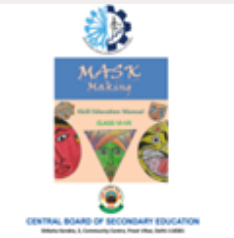
Food Preservation



Baking

Herbal Heritage

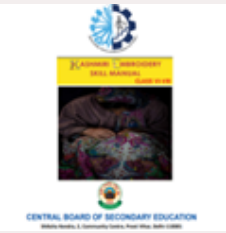
Khadi



Mask Making

Mass Media

Making of a Graphic Novel



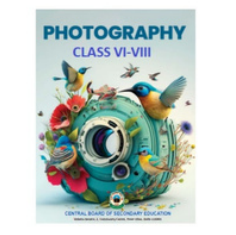
Kashmiri Embroidery

Embroidery

Rockets

Satellites

Application of Satellites



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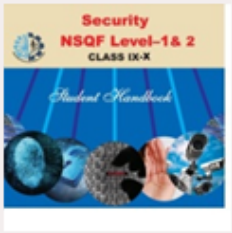
Retail

Information Technology



Security

Automotive

Introduction To Financial Markets

Introduction To Tourism

Beauty & Wellness

Agriculture

Food Production

Front Office Operations

Banking & Insurance

Marketing & Sales

Health Care

Apparel

Multi Media

Multi Skill Foundation Course

Artificial Intelligence

Physical Activity Trainer

Data Science

Electronics & Hardware (NEW)

Foundation Skills For Sciences (Pharmaceutical & Biotechnology)(NEW)

Design Thinking & Innovation (NEW)

SKILL SUBJECTS AT SR. SEC. LEVEL (CLASSES XI – XII)

Retail

InformationTechnology

Web Application

Automotive

Financial Markets Management

Tourism

Beauty & Wellness

Agriculture

Food Production

Front Office Operations

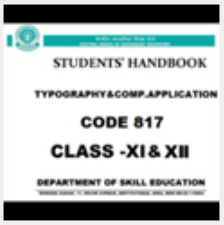
Banking

Marketing

Health Care

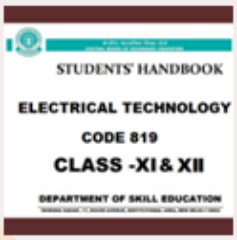
Insurance

Horticulture



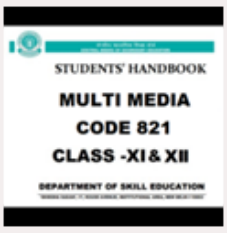
Typography & Comp. Application

Geospatial Technology



Electrical Technology

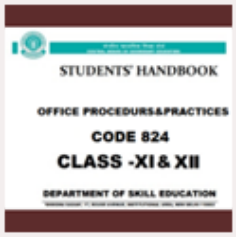
Electronic Technology



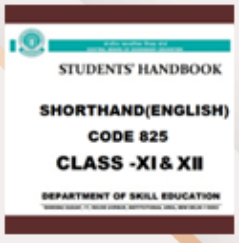
Multi-Media

Taxation

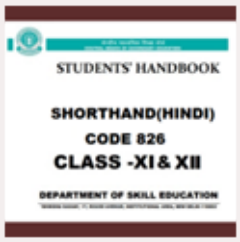
Cost Accounting



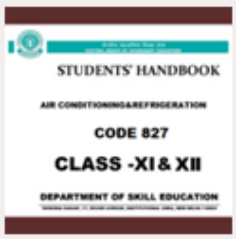
Office Procedures & Practices



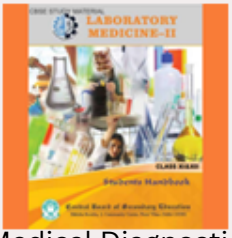
Shorthand (English)



Shorthand (Hindi)



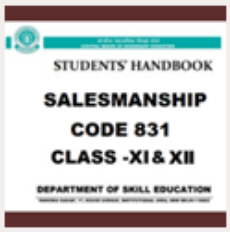
Air-Conditioning & Refrigeration



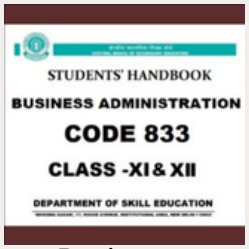
Medical Diagnostics

Textile Design

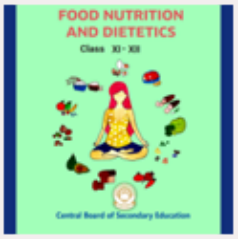
Design



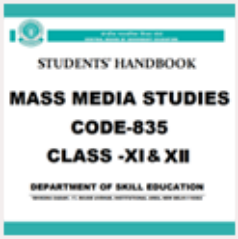
Salesmanship



Business Administration



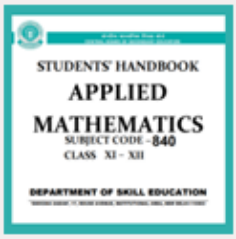
Food Nutrition & Dietetics



Mass Media Studies

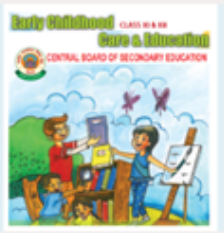
Library & Information Science

Fashion Studies



Applied Mathematics

Yoga

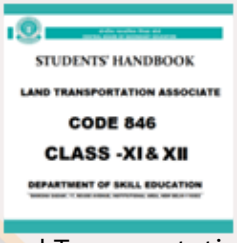


Early Childhood Care & Education

Artificial Intelligence

Data Science

Physical Activity Trainer(new)



Land Transportation Associate (NEW)

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Science

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Hindi-A

Hindi-B

IT Code-402

IT

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Chemistry

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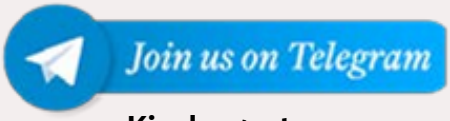
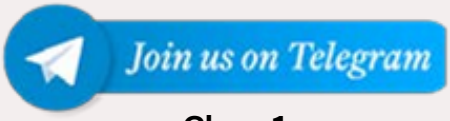
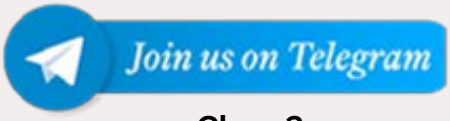


Kindergarten



Class 1



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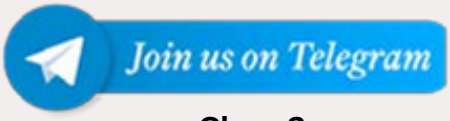

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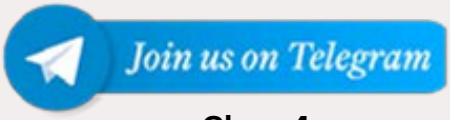

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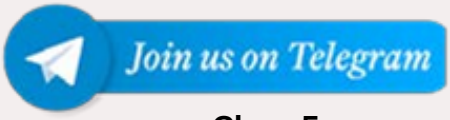
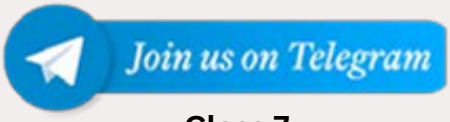


Class 5

Class 6



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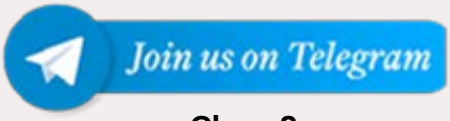

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